5.5.2 Wildlife Resources

This section summarizes the impacts to wildlife resources due to implementing either the Proposed Program or any of the alternatives. The wildlife species of concern and their habitat requirements are described in Section 4.5.2.

5.5.2.1 Significance Criteria

Based on the CEQA Guidelines, a project would have a significant impact on wildlife if it would

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the DFG or USFWS;
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;
- Conflict with any local policies or ordinances protecting biological resources; or
- Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional or state habitat conservation plan.

Based on other applicable wildlife protection laws, a project would have a significant biological impact if it would

- Take[1] any federally threatened or endangered species (FESA) without a permit
- Modify or degrade habitat to the degree that it substantial impairs essential behavioral patterns of any federally threatened or endangered species (FESA)
- Violate any regulation pertaining to any federally threatened or endangered species (FESA)
- Kill any state threatened or endangered species (CESA)
- Take[2] any bald or golden eagle, including their parts, nests, or eggs without a permit (BGEPA)
- Take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (raptors) or their nests or eggs (CDFG Code §3505.5)
- Wound or kill any native bird, from the egg stage onward (MBTA)
- Substantially adversely affect an existing fish or wildlife resource including species of special concern (CDFG)
- Take or possess any Fully Protected species or parts thereof at any time (CDFG §3511)

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[1] FESA defines “take” as to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct."

[2] BGEPA defines “take” as to “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.”

5.5.2.2 Determination Threshold

The following thresholds were used to determine whether a substantial adverse effect to wildlife resources would result from implementation of vegetation treatments under the Program or any of the alternatives.

The Proposed Program (or alternative) would be considered to have a substantial adverse effect on wildlife if it:

a) Violates any state or federal wildlife protection law or
b) Contributes directly (through immediate mortality) or indirectly (through reduced productivity, survivorship, genetic diversity, or environmental carrying capacity) to a substantial, long-term reduction in the viability of any native species or subspecies at the state level.

5.5.2.3.1 Data and Assumptions

Approach to Statewide Analyses

Effects of fuel reduction on wildlife depend on the specific ecological requirements of individual species and thus are difficult to generalize, especially in a treatment area as large and complex as that considered here. Furthermore, responses of wildlife to fuel reduction treatments have not been studied extensively and information on many taxonomic groups are completely lacking. Direct and indirect effects on wildlife are likely to differ. As a rule, negative effects will be greatest on species dependent on the fuels being removed, while positive effects will be greatest on species that have evolved in fire-dependent and other disturbance-prone ecosystems.

Effects of a given treatment will be influenced greatly by characteristics of adjacent parcels. An isolated patch of habitat will take much longer to recover from treatment than one surrounded by similar habitat. Treatments occurring near similar habitat will likely have less impact on wildlife, as the surrounding habitat will provide displaced animals somewhere to flee and facilitate their return to the treated area post-project as conditions become suitable.

To address potential direct and indirect effects of the VTP on wildlife in an ecologically meaningful way, species have been assigned to four broad guilds (subterranean (soil invertebrates, burrowing mammals, etc.), ground-dwelling (terrestrial invertebrates, reptiles and amphibians, including partially aquatic forms, and mammals), shrub-dwelling (shrub-nesting birds, etc.), and arboreal (arboreal invertebrates, cavity and tree nesting birds and mammals, etc.) based on how they typically use the vertical environment. Shaffer and Laudenslayer (2006) used similar guilds in addressing effects of fire on animals, but they considered shrub-dwelling species as a subset of arboreal fauna. Since many of the treatments considered here specifically target either scrub habitats or the shrub layer in wooded habitats, we have elevated shrub species to their own guild. We feel such an approach is preferable to addressing broad taxonomic guilds wherein species occupy the full range of available vertical strata because fuel reduction treatments in structurally complex habitats are typically layer-specific. Species are assigned to a single guild based on their primary or most critical (for instance, breeding or over-wintering) use area.

Prescribed fire will be the most common treatment type used to reduce fuels under the

Proposed Program, accounting for approximately 53% of all treatments (Table 2.4). Thus, prescribed fire will have the most-wide-ranging effects on wildlife throughout the treatment area. Since nearly all of California's vegetation types are fire-adapted (Sugihara and others, 2006), restoring fire to these communities should be mostly beneficial to wildlife so long as consideration is given to the natural fire regime on the landscape (Huff and others, 2005). Furthermore, prescribed fire treatments are typically low-intensity and patchy, resembling natural fire conditions more than the stand-replacement fires that often occur as a result of fire suppression. However, temporal and spatial effects as well as the short- and long-term effects that fire will have on the animals residing within these landscapes need to be considered (Shaffer and Laudenslayer, 2006).

Mechanical treatments typically are applied on a scale smaller than that of prescribed fire treatments, comparable to that of most biological treatments (browsing and grazing), and larger than that of manual treatments. The total acreage available for mechanical treatment in this program (27%) is less than that of any of the other treatment types with the exception of herbicides (Table 2.3); thus, all else being equal, the cumulative effects of this treatment type will be relatively minimal. Only 18% of the program will involve mechanical treatment (Table 2.4).

Although all the acreage available for treatment under the VTP is suitable for manual treatment (Table 2.3), manual treatment is labor-intensive and thus time-consuming and expensive and therefore expected to be implemented primarily in relatively small areas where other treatments are unfeasible. Only 10% of the acreage treated under the proposed program is likely to be treated manually (Table 2.4). Thus, given the relatively low impact of this treatment type and limited extent to which it is likely to be implemented, its cumulative impact on wildlife is expected to be extremely low. However, certain Mitigation Measures are still appropriate to minimize or avoid potential impacts.

Herbivory treatments also could be used in every VTP project (Table 2.3). However, this treatment type will account for only about 10% of the program (Table 2.4). Herbivory treatments will be reserved almost exclusively for removal of invasive plants and maintenance of previously treated areas such as firebreaks. Thus, their negative impact on wildlife is expected to be small, assuming that effects can be contained within intended treatment areas (that is, that livestock are confined and do not spread invasive plants). Managed livestock grazing can increase the productivity of selected species, increase the nutritive quality of the forage, and increase habitat diversity (Vavra, 2005). Ectoparasites such as ticks and mosquitoes will benefit from the introduction of additional hosts.

While each of the various treatment types proposed in this program come with potential negative direct and/or indirect effects on wildlife, one must weigh these effects against the known effects on wildlife of catastrophic wildfire, which in most cases in California is the inevitable eventual consequence of *lack* of fuel reduction. Stand-replacement wildfires kill and displace many animals, often over a huge area (greatly exceeding the area proposed for any VTP project), and set habitat succession back decades if not centuries. Negative effects on wildlife of any well-implemented, monitored, VTP project are likely to be minor in comparison.

Approach to Bioregional Analyses

Over 600 special-status wildlife taxa occur in California, and over 300 occur in habitats likely to be treated under the VTP. Appendix B lists the special status taxa considered herein. Addressing potential impacts of the VTP to every taxon at the programmatic level would be impractical. Thus a method was developed to focus analysis on taxa most likely to be affected by VTP treatments. A weighted value was assigned to each taxa based on a proxy for its abundance and whether or not it has been observed in areas that are likely to be treated by VTP treatments. More abundant taxa in areas more likely to be treated were assumed to have a higher likelihood of being affected by VTP treatments and thus were analyzed more intensively.

To identify those taxa most likely to be affected by VTP treatments, DFG's BIOS (Biogeographic Information and Observation System) database was queried to determine the numbers of occurrences of each taxon in watersheds classified as either "high" or "low likelihood" of receiving treatment (See Chapter 5.0 for discussion of how watersheds were assigned to these classifications). Watersheds categorized as "high-treatment-likelihood" were three times more likely to receive treatments than watersheds classified as "low-treatment-likelihood". Results of these queries were sorted by bioregion and summarized.

Ancillary BIOS data layers containing information on species whose occurrence location information is suppressed in the CNDDB BIOS layer (bald eagle (*Haliaeetus leucocephalus*), marbled murrelet (*Brachyramphus marmoratus*), spotted owl (*Strix occidentalis*), great gray owl (*Strix nebulosa*), Point Arena mountain beaver (*Aplodontia rufa nigra*), Sonoma tree vole (*Arborimus pomo*), and fisher (*Martes pennanti)* were also queried; however, these data could not be assigned to either watershed category. Taxa that occur only in vegetation types to be excluded from the VTP were disregarded. Occurrences of the remaining taxa in high-treatment-likelihood watersheds were weighted three times more than those in low-treatment-likelihood watersheds. A total occurrence value for each taxon in treatable habitats in the bioregion (O_b) was derived based on the formula,

$O_b = 3O_h+O_l+O_a$, where:

O_b = Total occurrence value for each taxon in treatable habitats in the bioregion

O_h = Number of occurrences in high-treatment-likelihood watersheds

O_l = Number of occurrences in low-treatment-likelihood watersheds

O_a = Number of occurrences in ancillary databases

Because the geographic distribution of BIOS data is highly skewed and does not reflect the distribution of VTP projects, one taxon was selected for analysis, based on occurrence values, in each bioregion for every ten VTP projects that will occur in that bioregion each year. A minimum of five taxa were analyzed for each bioregion. For example, if a given bioregion will receive 100 VTP projects annually, potential effects on the taxa in treated habitats with the ten highest occurrence values in that bioregion were analyzed; if the number of projects is only 10, five taxa were analyzed.

One shortcoming of this approach to species selection is that occurrences in portions of treatable watersheds outside CAL FIRE's jurisdiction could not be excluded. Thus, species may have been included or excluded that should not have been. Another shortcoming is that occurrence information in the databases does not necessarily reflect a taxon's actual distribution or abundance; a minority of species – typically the larger and more charismatic taxa - receives the majority of attention and funding. Invertebrates are especially poorly catalogued; there are likely many that deserve special status that are not yet even described. Finally, the cutoff for inclusion was necessarily arbitrary.

It is important to keep in mind that these are only the taxa expected to be *most likely* to require consideration before implementing VTP projects; a complete species list will need to be generated for impact analysis for each individual project. Thus, in accordance with the MMRs (Section 2.3), a BIOS query will need to be conducted at the project level and potential impacts to special-status taxa evaluated during the environmental review and completion of the environmental checklist.

Treatments were considered to have potentially adverse or beneficial effects within a vegetation type at the bioregion level if they will affect at least 1,000 acres or 0.1% of that vegetation type annually within the bioregion. Adverse and beneficial effects to wildlife were considered to be negligible in vegetation types that will receive less than 1,000 acres or 0.1% of that vegetation type treated annually. For the purpose of this bioregional analysis, adverse effects were considered to be significant if they would affect taxa that are listed as either threatened or endangered at the federal or state level. Furthermore, adverse effects to taxa that are considered state endangered or extremely endangered by the CNDDB (*i.e*., have a state rank of S2S3 or less) were also considered to be significant. Adverse effects at the bioregional level to taxa not meeting these protection criteria were considered moderately adverse.

In order to analyze the potential effects of implementing the Program or Alternatives it was necessary to consider the types of treatments proposed, the extent of those treatments and the Landscape Constraints (LCs) and Minimum Management Requirements (MMRs) included in the VTP that are designed to moderate potential impacts to wildlife species (Chapters 2 and 3).

Impacts to wildlife species as a result of the proposed project will be moderated with the implementation of MMR 5.

5.5.2.4 Direct Effects Common to all Bioregions From Implementing the Program/Alternatives

Direct effects are those of the treatment procedure itself (*i.e.*, during and shortly after treatment) as opposed to those that are a function of the desired fuel condition. Direct effects to special status wildlife taxa from fuel reduction treatments are inherently adverse and will not vary much between bioregions. Appendix B lists the special status wildlife species considered herein. Some potential exists for substantial adverse effects, but MMR 5 should prevent them. The extent of direct effects to wildlife by bioregion will be proportional to the amount of vegetation being treated in a particular bioregion.

Direct effects of fuel reduction on wildlife are likely to be highly dependent on treatment method. For this reason, we address these effects by treatment type, first as they apply to all wildlife and then as they apply to each guild in the vertical stratum. There is little literature on direct effects of fuel reduction on wildlife. Most of the effects discussed here are those one would expect given knowledge of wildlife behavior and ecology. Potential direct effects on wildlife of fuel reduction treatments are more likely to be negative than positive and include mortality and disturbance, though some individuals (*e.g.*, predators) can benefit from the negative effects on others (*e.g.*, prey).

Table 5.5.2.1 summarizes the information from the balance of this chapter on the direct effects to wildlife created through implementing the Proposed Program.

Table 5.5.2.1 **Summary of Direct Effects on Wildlife Resources from Implementing the Proposed Program**
Direct effects (those occurring as an immediate result of treatment implementation) are primarily negative in the short term and have the most adverse effects on species with limited mobility and those that are disturbance intolerant. Conversely, some predatory species may benefit from such effects on prey species that are exposed, injured or killed as a result of treatment. The direct effects discussed herein should be compared with the much more detrimental direct effects to wildlife that would result from catastrophic wildfire likely to occur in the absence of treatment. These include high levels of mortality and displacement of wildlife.

Treatment types

<u>Prescribed Fire Treatments</u>

In general, direct wildlife mortality due to fire is low since most animals are able to escape or take shelter (Lawrence, 1966; Smith, 2000). However, animals with limited mobility such as mollusks, salamanders, and young of more mobile species may succumb to fire. Since natural fires in California occur mostly in the late summer and fall, animals have adapted to this seasonal pattern by nesting and rearing their young during the spring and early summer. If seasonal activity patterns of these species are not taken into consideration and burning occurs during the spring or summer while immobile young are present, then wildlife mortality associated with burning may be high. Unfortunately, fires can get out of control during late summer and fall and so it is necessary to weigh the possibility of negative long-term effects to wildlife habitat and destruction of human development against the short-term effects of wildlife mortality.

Direct effects from disturbance may also have deleterious effects on wildlife within and adjacent to burn areas. For instance, wildlife may be disturbed by the presence of a large crew required to be on site during a prescribed burn in order to control it and keep it within the planned boundary. Additionally, noise from helicopters occasionally used to ignite fires or smoke drifting over a nest or den site may cause wildlife to leave the area. Control lines also may need to be established around the perimeter of the fire causing disturbances addressed above in the mechanical and manual treatment sections. Of particular concern, though, are the short-term consequences of burning near special-status taxa where disturbance may cause reproductive failure; these effects will be addressed in the bioregion-specific sections that follow.

Mechanical treatments

Unlike fire treatments, mechanical treatments typically leave, and in many cases create, considerable amounts of litter and debris, which then are often piled and/or burned. In fact, mechanical treatments are often used as a precursor to fire treatments by making fuel more manageable and creating control lines. Machines typically are noisier, and move more slowly than prescribed fire, alerting animals to the danger and allowing them time to escape; however, the noise itself may create a disturbance to sensitive wildlife not produced by other treatment types. Such disturbance may result in increased risk of predation or nest failure or disruption of essential behaviors. When mechanical treatments are applied when soils are relatively dry their potential for direct effects is relatively low for amphibians but relatively high for most other upland wildlife. Due to the varying climates throughout the state, mechanical treatments can be applied any time of the year with the exception of Red Flag Warnings and the presence of excessive soil moisture on the project site.

Manual treatments

Manual treatments typically have a gentler immediate impact on the environment than either fire or mechanical treatments. There is very little potential for direct mortality of wildlife from this treatment type. However, there is still considerable potential for disturbance, especially when power tools are used (see Mechanical Treatments section). Workers implementing manual treatments may traverse and disturb sensitive habitats such as talus slopes, rock outcrops, and streambeds that are inaccessible to fire and machinery.

Herbivory treatments

The level and nature of potential direct effects on native wildlife of fuel treatments using livestock are similar to those of manual treatments, though perhaps more concentrated and intense. There is some potential for disturbance but little for mortality beyond that already present from native ungulates.

No treatment

Stand-replacing wildfire is likely to occur eventually in most California ecosystems in the absence of fuel reduction. Such wildfires kill or displace most of the animals present and destroy their nests and often their shelters. A few predatory animals may benefit in the short term from the prey exposed, injured, or killed by these fires, but direct effects of catastrophic wildfire on animals are overwhelmingly negative.

Species guilds

Subterranean fauna

Prescribed Fire treatments

The direct impact that prescribed fire has on subterranean animals is dependent upon how deeply the fire heats the ground and whether smoke enters underground tunnels (Shaffer and Laudenslayer 2006). Fires will have little impact upon this guild if they burn lightly over the surface or stay mostly in woody vegetation. Additionally, wildlife in soils with high moisture content should be better protected from fire than wildlife in dry soils. However, high-temperature surface fires have the potential to harm fossorial animals and wildlife that seek shelter underground.

Invertebrates

Many invertebrates, including some subterranean species, have small distribution areas and are therefore particularly susceptible to habitat changes that result in direct mortality or habitat loss. However, a review of the scientific literature by Swengel (2001) found that fire has little direct impact on most subterranean invertebrates.

Overall mortality of invertebrates depends on the proportion of organic soil consumed by the fire and the depth of heating of the soil. Invertebrates that occupy deeper soil horizons are less vulnerable than those in the litter layers as are species with thick cuticles (Wikars and Schimmel, 2001).

Some ground-nesting (or "mining") bees, most often the more solitary species, are vulnerable to fire. These species are often key pollinators where they occur. Cane and Neff studied the susceptibility of such species to fire by testing their heat tolerance. They concluded that only a small fraction (9%) of the shallowest-nesting bees are the most vulnerable, owing to their shallow horizontal nests. They also suggested that because mining bees prevail in most biomes of the temperate zone, managers should plan for their survival post-burn, thus pollen and nectar resources in the years after fire should be considered (Cane and Neff, 2011).

Amphibians/Reptiles

Direct mortality or disturbance to amphibians and reptiles that burrow under cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild. No exclusively subterranean amphibians or reptiles occur in project areas.

Birds

Prescribed fire is unlikely to result in direct mortality to birds like burrowing owl that nest underground or some species of swallow that nest in burrows excavated in substrates such as sand banks, primarily in cliff faces and cut banks. Fire severity and the depth of the nest are factors affecting potential mortality for burrowing birds.

Mammals

Direct mortality of small mammals as a result of fire is primarily from heat effects and asphyxiation. Using cooler prescriptions may reduce heat effects.

Studies suggest that mortality of burrowing mammals as a result of fire is low as a result of the insulation provided by the soil (Kramp et al., 1983) for species that are underground or able to escape there when a fire burns through.

Other causes of death resulting from fire include physiological stress as animals overexert themselves to escape, trampling as large animals stampede while fleeing, and predation while attempting to escape (Kaufman et al., 1990).

Mechanical treatments

Fossorial animals can avoid direct mortality from motorized equipment either by virtue of being underground already or by escaping into burrows. However, heavy equipment may compact the soil and collapse burrows, crushing or burying the animals therein. Chaining, tilling, and grubbing, which uproot vegetation, may displace or kill wildlife living in the root masses. Drill seeding has the potential to kill soil micro-fauna near the surface. Overall, mechanical treatments, particularly those that uproot vegetation, pose a greater direct threat to the subterranean fauna than do any of the other treatment types proposed in this program.

Invertebrates

Soil invertebrates play an essential role in decomposition and nutrient cycling and include detritivores such as earthworms and arthropods and species active in decomposition of dead wood on the forest floor such as termites, beetles, and ants. Although not well studied, researchers believe that thinning is likely to have significant short-term negative effects on invertebrates of the soil and organic layers as a result of treatments that will cause soil compaction and disruption or loss of organic layers (Niwa et al., 2001). Direct impacts include mortality and loss of food and cover. Hanula and Wade have shown that in some ecosystems these species can have long recovery periods post-treatment (Hanula and Wade, 2003). Soil invertebrates may be more protected from such effects than those in the litter layers (ODF, 2008).

Amphibians/Reptiles

Direct effects to amphibians and reptiles that burrow under cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild. No truly subterranean amphibians or reptiles occur in project areas.

Birds

The potential direct effects of mechanical treatments on burrowing owl, a special status species that utilizes the burrows of other species, are addressed in the "Shrub-dwelling Fauna" section. No truly subterranean birds exist.

Mammals

Direct effects of mechanical treatments on subterranean mammals are primarily negative and include mortality, injury, or habitat destruction as a result of soil compaction and/or collapsed burrows. However, long-term indirect effects to this guild are mostly positive (see Section 5.5.2.5).

Manual treatments

Manual treatments have much less potential for direct effects on this guild than do fire or mechanical treatments. Soil compaction is essentially a negligible concern. Humans on foot can collapse burrows but are also better able than machine operators to avoid them. Treatments such as pulling and hoeing that uproot vegetation can cause disturbance and even mortality to wildlife, especially invertebrates, inhabiting the root masses.

Invertebrates

Manual fuel treatments are likely to have the most detrimental direct effects on invertebrates. These are primarily a result of manual treatments. As mentioned above, treatments that uproot vegetation can disturb, injure or result in mortality of subterranean invertebrates. Uprooting accounts for a disproportionate level of this treatment type's impact because manual treatments often are selectively applied where soil conditions allow for complete plant removal, but the plants involved (and their root masses) are relatively small and shallow.

Amphibians/Reptiles

Direct effects of manual treatments on amphibians and reptiles that burrow under cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild. No exclusively subterranean amphibians or reptiles occur in project areas.

Birds

No truly subterranean bird species occur in California.

Mammals

Direct effects to mammals from manual treatments primarily include disturbance to subterranean mammals while workers are on site. However, possible injury or mortality could also occur as a result of burrow collapse and soil compaction but, as mentioned above, hand crews are more likely to avoid destruction of burrows than equipment used for mechanical treatments.

Herbivory treatments

A livestock herd placed on a site for vegetation control may affect virtually the entire surface area of the site. There is considerable potential for burrows to be destroyed and, if the herd is left there long enough, the soil to be compacted. Further, herds can introduce parasites and/or disease into wildlife systems. However, little uprooting of vegetation occurs with herbivory and subterranean fauna will be affected far less than from ground-disturbing mechanical treatments. Negative effects can be minimized through proper management of herds, such as herding them around sensitive areas, preventing them from remaining in any one location for long periods and taking preventative measure to avoid the introduction of parasites/disease.

Invertebrates

Subterranean invertebrates could suffer injury or mortality as a direct result of herbivory treatments due to soil compaction and burrow collapse. The significance of these impacts are relative to the herd size and how much of the landscape will be treated as well as the density and distribution of the affected taxa.

Amphibians/Reptiles

Impacts to subterranean herpetofauna are similar to those on subterranean invertebrates, injury and/or mortality related to soil compaction and burrow collapse.

Birds

The only species of bird occurring in the project area that is appropriate for consideration in this section is burrowing owl since it nests in underground burrows. Herbivory is not expected to have any direct effects on burrowing owl as the species has evolved in grazed habitats, having evolved alongside bison herds. In fact, the indirect effects of grazing on burrowing owl are positive as grazing pressure has been shown to enhance the suitability of burrowing owl habitat by maintaining low vegetation height at nest burrows (Murray, 2005).

Mammals

As is the case with other subterranean fauna, subterranean mammals are vulnerable to injury and/or mortality as a direct effect of soil compaction and/or burrow collapse likely to occur as a result of herbivory treatments

<u>Ground-dwelling fauna</u>

Prescribed Fire

Direct mortality of ground-dwelling wildlife is expected for taxa that cannot escape or take adequate cover from fire. In general, large mammals and flighted animals will be able to escape fire, but may occasionally succumb to smoke inhalation (Smith, 2000). Certain burn techniques may entrap wildlife such as blacklining a perimeter or lighting large, fast moving grass fires. If firing occurs simultaneously at perimeter locations, animals may be unable to escape. Prescribed fires in the spring and summer will have the greatest direct impact upon animals that are nesting or rearing their young on the ground such as woodrats (Lawrence, 1966; Simons, 1991). The long-term effects of the reproductive loss may be ameliorated for some species that can reproduce again within a single breeding season, but many species will be unable to breed again until the following year. Wildlife with limited mobility, such as salamanders and flightless invertebrates, may seek shelter from fire in the leaf litter where moisture content and fire duration will determine the extent of mortality. Mollusks are likely to be sheltered from fire since they generally reside under cover objects in forest environments dry enough to carry a fire (J. Dunk, pers. comm.). Pile burning may kill wildlife when piles of slash and woody debris have been left unattended long enough for wildlife to start using them as shelter. See the section above on subterranean fauna for effects on ground-dwelling species that seek shelter from fire by going underground.

Invertebrates

The direct effects of prescribed fire on ground-dwelling insects and other invertebrates depend largely on their location at the time of the fire and fire intensity, which depends, in part, on duff consumption. Most adult forms can burrow or fly to escape injury or mortality (Lyon et al., 2008). Meanwhile, many invertebrates have immobile life stages that occur in surface litter or aboveground where they are much more susceptible to the effects of fire.

Ground-dwelling invertebrates are substantially more vulnerable to prescribed fire than burrowing invertebrates because they are unable to seek protection in the soil (Lyon et al., 2008).

Amphibians/Reptiles

The herpetofaunal species most vulnerable to fire are those that require leaf litter, duff, and other cool, moist substrates that are usually consumed by fire. Direct mortality and/or injury of terrestrial amphibians and reptiles as a result of prescribed fire is believed to be rare and of negligible concern at the population level (Lyon et al., 1978; Means and Campbell, 1981, Russel et al., 1999; and Smith, 2000). This is based on the continued presence of live amphibians post-fire. Survival is likely a result of the ability of some life stages of terrestrial herpetofauna to seek shelter in underground burrows or under moist refugia (Bamford, 1992; Friend, 1993; Main, 1981; and Vogl 1973). A study in Australia found that one species of anuran (*Hyperolius nitidulus*) can detect the sound of fire and respond by moving toward cover (Grafe et al., 2002).

However, fast-moving fires may not allow enough time for amphibians and reptiles to seek refuge. Therefore, immediate impacts of fire to herpetofauna may be minimized by using slow-burning prescriptions to reduce direct mortality. Mortality of aquatic life stages such as eggs and larval herpetofauna are rarely reported and possibly inconsequential (Driscoll and Roberts, 1997 and Lyon et al., 1978). Although aquatic forms are typically much more protected from fire than terrestrial forms, mortality could result from thermal stress or rapid changes in water chemistry in streams, ponds and other aquatic habitats (Spencer and Hauer, 1991).

Birds

Direct mortality and/or injury to ground-dwelling birds as a result of prescribed fire are highly dependent upon the season, uniformity and severity of the burn (Lyon and Telfer, 2008). Adult mortality is considered low. However, burns occurring during the breeding season substantial increase the risk of mortality to ground-nesting species, especially eggs, nestlings and fledglings.

Nest destruction and mortality of young have been reported for a number of ground-nesters including ruffed, spruce, and sharp-tailed grouse (Grange, 1948), northern harrier (Kruse and Piehl, 1986), and greater prairie chicken (Svedarsky et al., 1986). A study conducted on prescribed fires in the Blue Mountains in Oregon used artificial nests to assess mortality of ground-nesting birds as a result of spring burning. It found that direct mortality of ground nests could result. The same study showed that the level of mortality caused by spring burns could be correlated with the method of administering the burn. Spring burns administered by helicopter appeared to be more patchy than those administered by drip-torch thus resulting in lower mortality of artificial nests (22%) compared with spring burns administered by drip-torch (44%) (Fosdick, 2005).

Reproductive success may also be reduced the first year following a fire due to decreased availability of food from spring fires (Finch et al., 1997). As mentioned above, ground-nesting birds that re-nest following a nest failure are affected less than those that do not.

Mammals

Direct mortality or injury to ground-dwelling mammals as a result of prescribed fire is largely dependent on the mobility of the species and intensity and uniformity of the burn. In general, larger, more mobile species such as ungulates, top carnivores, mesocarnivores, etc. are better able to flee from a fire with the possible exception of newborn, old, and sick individuals.

Smaller ground-dwelling mammals with less mobility such as rodents and lagomorphs are at greater risk of direct impacts from prescribed fire. Those that lack the ability to burrow or cannot escape to cover or flee from a fire quickly enough are particularly susceptible.

Mechanical treatments

Invertebrates, amphibians, reptiles, bird eggs and nestlings, and small mammals may be crushed by machinery during mechanical treatments. More mobile species may be displaced temporarily but are very unlikely to be killed directly by mechanical treatments, though opportunistic predators may kill them or they may find themselves in inhospitable habitat or conspecific territory after being flushed from shelter. Treatments that uproot vegetation can cause disturbance and potential mortality to the ground dwellers underneath. Chaining and machine piling disrupt the litter layer and displace animal shelters such as rocks and logs, exposing wildlife to predation or desiccation; this has a beneficial immediate effect on the predators. Mastication and mechanical lop-and-scatter treatments are likely to kill less-mobile wildlife sheltering in the slash produced by earlier mechanical treatment.

Although mechanical treatments disrupt ground cover initially, they typically do not remove it to the extent that fire does. In fact, mechanical treatments alone, if not followed by fire, often *increase* the amount of ground cover and thus can be beneficial to some terrestrial organisms in the long run. Debris piles provide homes for many animals, though these are often only temporary and animals taking up residence in them can be killed if the piles are destroyed.

Invertebrates

Invertebrates are generally short-lived and have a small dispersal range or are sedentary during one or more life stages. Therefore, mechanical treatments can potentially affect local populations through direct injury and/or mortality depending on the season, type, and size of the treatment. Species with life stages associated with the litter or duff layer are particularly susceptible to injury or mortality from mechanical treatments (ODF, 2008).

The provision of refugia (leaving untreated areas from which populations can recolonize) are important for minimizing the effects of direct mortality to ground-dwelling invertebrates and accelerating recovery (Pilliod et al., 2006).

Invertebrates of the forest soil play an important role in decomposition and nutrient cycling. These include detritivores such as snails, slugs, and arthropods. Niwa et al., (2001) suggest that thinning likely has substantial negative short-term effects on invertebrates associated with organic layers due to soil compaction and disruption or loss of organic layers, dependent upon soil type and thinning treatment.

Amphibians/Reptiles

Little is known about the direct effects of mechanical treatments on reptiles but injury and mortality are likely to be slightly less substantial than to amphibians given that reptiles generally have a bit greater mobility. However, all terrestrial herpetofauna are at risk of direct injury and/or mortality from mechanical treatments.

Birds

Direct effects of mechanical treatments are primarily disturbance, injury, and/or mortality of eggs and nestlings of ground-nesting birds (Smith, 2000). Such treatments are also likely to result in loss of nesting habitat in the short-term. (Pilliod et al., 2006)

Mammals

Direct effects of mechanical treatments on large, mobile mammals are not expected to occur with the exception of disturbance during the breeding season which would likely be at a negligible level due to the large home ranges of larger mammals. Although there is a slightly greater chance that smaller, less mobile mammals may suffer direct injury and/or mortality, it is unlikely to occur at a significant level. The exception is nest destruction or mortality of the young of small, ground-nesting mammals.

Manual treatments

As with subterranean fauna, manual treatments generally have less direct impact on ground-dwelling fauna than do fire or mechanical treatments. They typically do not disturb animal shelters such as rocks and logs. Manual treatments often generate large amounts of slash, which then can be spread over the ground or piled to provide cover for terrestrial wildlife.

As with mechanical treatments, manual treatments can cause disturbance to ground-dwelling animals, possibly resulting in their death. Ground-nesting birds and small mammals can be flushed off their nests, resulting in nest failure through abandonment, exposure, or predation and workers can crush nests directly. However, the potential for such effects is less than with most other treatment types.

Invertebrates

While some direct effects could occur to ground-dwelling invertebrates as a result of manual treatments from trampling by hand crews or disturbance from tools, such direct mortality is much less likely to occur with manual treatments than with prescribed fire or mechanical treatments.

Amphibians/Reptiles

Direct injury and mortality to terrestrial herpetofauna are also less likely to occur with manual than other treatments as a result of trampling, disturbance from tools, and removal of cover objects.

Birds

Injury and/or mortality to ground-nesting birds can occur as a result of trampling or ground disturbing activities associated manual treatments. As mentioned above, nest failure could also result as a response to disturbance.

Mammals

Direct effects on terrestrial mammals potentially resulting from manual treatments are most likely to occur during the breeding season to small mammals that rear their young on the ground.

Herbivory treatments

Invertebrates

Invertebrates may be killed or injured as a result of trampling.

Amphibians/Reptiles

If applied in habitat suitable for less mobile species or life stages of herpetofauna, herbivory treatments could result in injury or death due to trampling, especially when herds are flushed.

Birds

Ground nesting birds are vulnerable to trampling of eggs and nests by livestock trampling where herbivory treatments are applied.

Mammals

As with ground-nesting birds, small mammals that rear their young on the ground are susceptible to trampling by livestock in areas treated with herbivory.

Shrub-dwelling fauna

Prescribed Fire

Most shrub-dwelling wildlife will be able to avoid direct mortality by flying away or taking shelter on or under the ground before the fire arrives (see sections above for effects on subterranean and ground-dwelling species). Any animals that cannot escape the shrub environment prior to the arrival of the fire will be killed. Spring and summer fires will result in the loss of bird and rodent nests placed in shrubs. Stem-nesting invertebrates will also suffer high mortality.

Invertebrates

Direct effects of prescribed fire on shrub-dwelling invertebrates are highly dependent on their mobility. Adult and flighted forms are likely to escape fire whereas less mobile or sedentary forms that reside on aboveground plant tissue are more susceptible to injury and mortality from fire. Therefore, seasonality of the burn is important and invertebrate phenology should be considered when planning the timing of the burn.

Amphibians/Reptiles

No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.

Birds

As with ground-nesting birds, direct injury or mortality can occur to shrub-nesting birds during the breeding season, although perhaps to a lesser degree. However, potential short-terms impacts to shrub-nesting taxa should be assessed when considering spring burns.

Mammals

As with terrestrial mammals, immediate impacts of prescribed fire on shrub-nesting mammals such as some rodents have the greatest potential for occurrence during the breeding season.

Therefore breeding biology of shrub-nesting mammals should be considered when scheduling burns.

Mechanical treatments

Potential direct effects of mechanical treatments on shrub-dwelling species are similar to those on ground-dwellers. Treatments that destroy shrubs will displace and potentially kill wildlife living in them, and mechanical treatments are particularly effective for treating shrubby vegetation. The creation of firebreaks is likely to affect shrub-dwelling wildlife more than any other guild.

Invertebrates

Many shrub-dwelling invertebrates are at particular risk of suffering immediate adverse impacts, primarily displacement, from manual treatments owing to the fact that shrubs are often the targets of mechanical treatments (ODF, 2008). Similar to terrestrial invertebrates, immobile or sedentary life stages are at the greatest risk of direct injury and mortality from mechanical treatments.

Amphibians/Reptiles

No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.

Birds

Shrub-nesting birds are the most vulnerable to mechanical treatments that remove shrubs during the breeding season when displacement, nest failure, and injury or mortality to nestlings are likely to result. Therefore the breeding biology of shrub-nesting birds should be taken into account when applying mechanical treatments.

Once again, seasonality of the treatment application is key in determining the direct effects to shrub-dwelling fauna. Mechanical treatments that remove shrubs will have the greatest impact on small mammals such as rodents that nest therein. As with prescribed fire, breeding biology of shrub-nesting mammals should be considered when scheduling mechanical treatments.

Manual treatments

Manual treatments that remove shrubby vegetation will have impacts on shrub-dwelling fauna similar to those of mechanical treatments. However, manual treatments are unlikely to be applied in extensive, dense brush-fields and thus will have relatively minimal impact on this guild.

Invertebrates

Please see the section on mechanical treatments and shrub-dwelling invertebrates, as the effects of manual treatments that remove shrubby vegetation are the same. However, effects from manual treatments are likely to occur on a smaller scale since smaller tracts are expected to receive manual treatments compared to mechanical treatments.

Amphibians/Reptiles

No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.

Birds

Please see the section on mechanical treatments and shrub-dwelling birds, as the effects of manual treatments that remove shrubby vegetation are the same. However, effects from manual treatments are likely to occur on a smaller scale since smaller tracts are expected to receive manual treatments compared to mechanical treatments. Also, hand crews may be better able than machine operators to identify and avoid bird nests.

Mammals

Please see the section on mechanical treatments and shrub-dwelling mammals, as the effects of manual treatments that remove shrubby vegetation are the same. However, effects from manual treatments are likely to occur on a smaller scale since smaller tracts are expected to receive manual treatments compared to mechanical treatments. Also, hand crews may be better able than machine operators to identify and avoid mammal nests.

Herbivory treatments

Livestock, especially goats, may be used specifically to reduce or eliminate shrubs, displacing or possibly injuring or killing, some animals inhabiting those shrubs. Nests of shrub-nesting birds will be left exposed to the elements and predators and may be knocked down or destroyed directly by the browsers.

Invertebrates

Because herbivory may be used as a method of shrub removal, the effects of this treatment are the same as for mechanical and manual (above). The extent of such impacts is highly dependent upon the seasonality of the treatment application, as it applies to the phenology of shrub-dwelling invertebrates, and the extent of the landscape treated.

Amphibians/Reptiles

No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.

Birds

Because herbivory may be used as a method of shrub removal, the effects of this treatment are the same as for mechanical and manual (above). The extent of such impacts is highly dependent upon the seasonality of the treatment application, as it applies to the breeding biology of shrub-nesting birds, and the extent of the landscape treated.

Mammals

Because herbivory may be used as a method of shrub removal, the effects of this treatment are the same as for mechanical and manual (above). The extent of such impacts is highly dependent upon the seasonality of the treatment application, as it applies to the breeding biology of shrub-nesting mammals, and the extent of the landscape treated.

Arboreal fauna

Prescribed Fire

The effects of fire on arboreal species are more variable than their effects on other guilds. In general, prescribed fires occurring under the proposed program are not intended to burn large trees, so effects on this guild should be minimal. Cool understory fires, conducted during the rainy season, are unlikely to burn in the canopy and thus should not cause direct mortality of canopy-dwelling fauna. The most likely cause of death would be the result of smoke inhalation, although most arboreal animals are likely to leave the area prior to the arrival of the fire. Fires that burn snags may cause them to fall, resulting in the destruction of nests that may occur within them or direct mortality of animals potentially using them for shelter and/or the rearing of young. If fires do get into the forest canopy, bird and rodent nests will be destroyed and immobile young will die. Disturbance from fire, including noise, smoke, and heat, may cause birds and mammals to abandon nests or flush from roosts, whereupon they may experience nest failure, energetic deficits and/or heightened predation risk.

Invertebrates

Prescribed fire treatments to be applied under the proposed program are not expected to burn large tree species in the canopy and therefore are unlikely to result in direct harm to arboreal invertebrates.

Amphibians/Reptiles

Many species of amphibians and reptiles exhibit arboreal habits and often forage on invertebrates that breed in foliage or seek shelter in trees. Some such taxa include tree frogs, snakes, lizards, and salamanders.

These species are not expected to suffer direct effects as a result of prescribed fire as such treatments, under the proposed program, are likely to be cool prescriptions that would not burn into the canopy. Mortality could occur as a result of asphyxiation but even that is not likely as most “arboreal” herpetofauna, even frogs, are highly mobile and can escape the effects of fire in most situations.

Birds

Again, because treatments applied under the proposed program are expected to be cooler prescriptions that will not burn large canopy trees, arboreal bird species are largely expected to escape direct impacts resulting from prescribed fire. However, consideration should be given to cavity nesting birds when applying prescribed burn treatments such that defect trees/snags are avoided as well.

Mammals

As with other arboreal species, arboreal mammals are expected to largely escape direct impacts resulting from prescribed fire treatments under the proposed program as long as such treatments do not result in combustion in the canopy. Maternal roost colonies of some bat species occurring in buildings and caves can be adversely affected by smoke inhalation as a result of prescribed burning, especially in the spring.

Mechanical treatments

Many mechanical treatment methods are used to treat vegetation on or near ground level and thus have relatively little direct impact on wildlife inhabiting the trees above. However, some mechanical thinning of trees will occur and noise and tremors from mechanical treatments on the ground can disturb animals in trees, resulting in predation and nest failure events. Thus, direct effects of mechanical treatments on arboreal fauna may be adverse.

Invertebrates

Removal of trees or snags via mechanical treatments may result in disturbance, injury, or mortality of invertebrates with relatively immobile or sedentary arboreal life stages. However, treatments that remove these habitat elements are not expected to occur on a large scale under the proposed program.

Amphibians/Reptiles

Again, because mechanical treatment applications under the proposed program are not expected to remove many mature trees, arboreal herpetofauna are unlikely to suffer adverse direct impacts from this treatment type. However disturbance, injury, or mortality could occur on a small scale if trees that support herpetofauna with arboreal habits are removed.

Birds

Birds are unlikely to suffer direct effects from mechanical treatments, as canopy tree removal under the proposed program will be minimal. However, some disturbance, injury, or mortality to arboreal or cavity nests or immobile nestlings could occur where mature trees or snags are removed.

Mammals

Similar to arboreal nesting birds, mammals that breed in the forest canopy are unlikely to suffer direct effects from mechanical treatments as canopy tree removal under the proposed program will be minimal. However, some disturbance, injury, or mortality to arboreal or cavity nests or immobile young could occur where mature trees or snags are removed.

Manual treatments

Manual treatments that destroy trees will have effects on arboreal fauna similar to those of mechanical treatments. Although arboreal animals can be disturbed by chainsaws, etc., on the ground, they are less likely to be disturbed by manual treatments aimed at herbaceous and shrubby vegetation than by equivalent mechanical treatments.

Invertebrates

See above.

Amphibians/Reptiles

See above.

Birds

See above.

Mammals

See above.

Herbivory treatments

Herbivory treatments are not expected to have any direct effects on arboreal wildlife. Therefore, no further sub-guild discussion is necessary.

5.5.2.5 Indirect Effects of Implementing the Program/Alternatives

Indirect effects apply after the immediate effects of the treatment have dissipated and are a function of the desired fuel condition and the regeneration process. These effects will vary over time as animals respond to seral changes in vegetation structure. In the absence of re-treatment or wildfire, indirect effects of treatment can be expected to diminish over time as treated stands approach pre-treatment conditions. Short- and long-term effects on a given species may differ, but it is impractical to try to define these terms consistently for species that vary greatly in life strategy and generation time or across vegetation types with varying rates of regeneration. As with any change in the environment, fuel reduction will benefit some species, harm others, and have no effect on the rest. In general, treatments that reverse the effects of fire suppression in fire-adapted ecosystems can be expected to benefit the wildlife that evolved therein and be detrimental to wildlife that favors fire-suppressed habitats. In discussing indirect effects of fuel reduction on wildlife, one also must consider the potential risk to wildlife of stand-replacing fire in the absence of fuel reduction (North et al., 2009).

Indirect effects of fuel reduction on wildlife relate to habitat conditions (including structure, vegetation composition, soil condition, and microclimate) resulting from treatment. These attributes are often independent of treatment type, since in many cases various treatments are merely different means to the same end or are used in tandem to achieve the desired condition (*e.g.*, create a shaded fuel break). In other cases, treatment method has a major influence on which habitat elements are removed and which are retained (*e.g.*, prescribed fire). Researchers examining these effects often have not addressed specific treatment methods and have grouped wildlife in various ways, making it difficult in many cases to relate individual studies to specific treatments or address guilds in a consistent manner. Additionally, many specific fuel treatment methods have not been in use long enough for their long-term effects to be studied.

Studies on wildlife responses to "disturbance" events, whether natural or anthropogenic, often group events into several broad categories, especially fire, thinning, and grazing. Pilliod and others (2006) define thinning in forest habitats as "a reduction in the density of understory trees through the removal of selected trees and shrubs." This definition can be applied more broadly to include mechanical or manual treatments in any habitat and removal of larger trees (not just those in the understory), and we use the term 'thinning' to include mechanical and manual thinning and clearing. Manual treatment can be more selective and may be preferred in situations in which retention of specific wildlife habitat elements is important. Manual treatment also may mimic grazing in effects on vegetation structure. On sites that are thinned and then burned to remove the slash, the long-term effects will be those of both thinning *and* fire.

Some fuel reduction treatments may create habitat configurations that are particularly harmful to some wildlife, particularly those species dependent on large tracts of habitat and sensitive to edge effects. Fire control lines often fragment contiguous blocks of habitat or sever wildlife corridors. They may create barriers to dispersal and gene flow and edge effects such as increased nest predation and brood parasitism. Treatments may be used to remove entire patches of vegetation, thus resulting in habitat loss for some wildlife. Leaving islands of intact habitat within treatment areas provides refugia for wildlife and source populations when the treated habitat begins to recover.

Treatment types

Prescribed Fire

Prescribed fires are intended to mimic low-intensity wildfires and thus usually have similar indirect effects. In forested environments, prescribed fires are mostly constrained to the understory, although fires may occasionally get into the canopy. In shrublands and grasslands, prescribed fires will be stand replacing, but these fires will generally be smaller in extent and intensity than a natural wildfire. After a fire has reduced the structural complexity of a habitat, habitat generalists tend to do better than habitat specialists as they typically adapt more easily to open space and can take advantage of new growth. Conversely, there are some fire specialists that are more abundant in recently burned habitats than in late-successional, "climax" habitats. As the vegetation proceeds through succession, different species of wildlife will occupy the affected area. Low-intensity, prescribed fires often leave pockets of unburned habitat, which can provide important refugia for wildlife to recolonize the burned area once the vegetation reestablishes itself. In general, wildlife populations will recover from a prescribed fire more quickly if the surrounding habitat is in good condition. Maintenance treatments that remove refugia or are repeated more frequently than the natural fire return interval for a given habitat will convert habitats to a younger seral stage for an unnaturally long period of time. When the maintenance treatments are eventually terminated, the affected habitat may no longer have all of its essential elements and thus may never fully recover to its pre-treatment condition. Overall, though, the primary goal of the VTP is to reduce the risk of catastrophic wildfire and not necessarily mimic the natural fire regime. In the short term, this may be less harmful to wildlife than wildfire, but it may not provide all of the long-term benefits of a natural fire regime.

Thinning

Thinning, whether mechanical or manual, causes changes in habitats that can affect wildlife in various ways. Opening the canopy creates gaps that allow more sunlight to reach the ground, resulting in warmer, drier ambient conditions. Added sunlight promotes the growth of vegetation, initially grasses, herbs, and forbs, and then shrubs and tree seedlings. These changes will benefit certain species but act to the detriment of others. Arboreal forest species may lose habitat connectivity and face reduced foraging, breeding, dispersal, and migration opportunities. Thinning treatments often target the sub-canopy layer, affecting the wildlife of that layer most strongly. In general, thinning may harm species of cool, moist forests most, while species of disturbed and early successional habitats are likely to benefit. Thinning appears to have minimal effects on wildlife if it is done in small patches, stem reduction is 25% or less, and legacy features are retained (*e.g.*, CalPIF, 2002, Alexander and others, 2007).

<u>Herbivory</u>

Virtually all California ecosystems evolved with ungulates contributing some degree of grazing and/or browsing pressure. Thus, fuel reduction by these means may be thought to mimic natural processes in its indirect effects. To some degree, it does, but natural levels of herbivory, especially in wooded habitats, virtually never reached the intensity at which they are typically applied for vegetation treatment by livestock. Furthermore, many treatment areas already support normal or artificially high population levels of native ungulates, to which the effects of livestock would be additive. Still, reduction or removal of non-native vegetation, the primary objective of biological treatment under the VTP, only can be seen as beneficial to most native wildlife provided native vegetation is allowed to replace it. It should be pointed out, however, that many native wildlife species have adapted to use non-native vegetation for food, shelter, substrate, and nest material, especially where it has supplanted the native species with which they evolved, and abrupt removal of this vegetation may leave such animals without critical resources.

<u>No treatment</u>

Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

Species guilds

<u>Subterranean fauna</u>

Prescribed Fire

For species that live their entire lives underground, indirect effects attributed to fire are mostly dependent upon how deeply the fire heats the ground. Hot surface fires may sterilize the upper soil horizons thereby reducing the organic matter and availability of food, which would in turn make the soil less productive for wildlife. However, since most prescribed fires should be relatively low intensity, their initial impact should be more beneficial to this guild. Consumption of shrubs and leaf litter by fire releases a flush of organic matter into the soil, causing a short-term increase in soil richness and productivity (Shaffer and Laudenslayer 2006). If prescribed fire increases sunlight due to a reduction in canopy cover, this may dry out the upper soil horizons causing the soil to become unsuitable to some species, but more suitable for others. See the section on ground-dwelling fauna for indirect effects to species that forage above ground.

Invertebrates

Indirect long-term effects of prescribed fire on soil invertebrates are positive for some species and negative for others.

Metz and Farrier found that an August understory burn in South Carolina forest reduced the soil mesofauna, as measured the day after the fire, but annually burned plots had generally higher populations of soil mesofauna than those that had not been burned in three or more years (Metz and Farrier, 1971).

Meanwhile, Kalisz and Powell reported on the changes in the soil invertebrate community on ridges of the Cumberland Plateau of Kentucky, USA one year after a prescribed fire (Kalisz and Powell, 2000). They quantified a significant reduction (36%) in the total dry mass of soil invertebrates as a result of the fire. Burning was also shown to result in declines in the frequency and occurrence of mesofaunal ants and of macrofaunal beetle larvae and adults. They suggested that managers should consider the possibility that prescribed fire, especially if applied repeatedly and at short intervals, may result in substantial and possibly long-lasting reductions in beetle populations. This may be prevented if managers strive for spatial and temporal heterogeneity on multiple scales, resulting in increased complexity in the post-fire ecosystem (Kalisz and Powell, 2000).

Amphibians/Reptiles

No exclusively subterranean amphibians or reptiles occur in California.

Birds

No exclusively subterranean birds occur in California. However, a discussion of burrowing owl is appropriate here because it nests in the underground burrows of other taxa. Little information exists on the indirect effects of prescribed fire on burrowing owl. However, in north central Oregon, burrowing owls were observed nesting in previously unused areas that had recently been burned, suggesting that fire may create suitable habitat by reducing vegetation around potential nest sites and foraging habitat (Green and Anthony, 1989). Additionally, in northwestern North Dakota, post-settlement fire suppression may be responsible for the development of a taller, denser, and woodier plant community than previously existed. Such shifts in vegetation composition may have been responsible for the local extirpation of burrowing owls there (Murray, 2005).

Mammals

Little information exists on the effects of fire on subterranean mammals. Because most mammals that utilize subterranean habitat also inhabit the terrestrial landscape, the indirect effects are addressed in the ground-dwelling fauna section.

Thinning

Invertebrates

Soil compaction from mechanical thinning can make soil uninhabitable by detritivores (earthworms, mites, springtails, *etc.*; Battigelli and others, 2004), at least in the short-term. However, there is some evidence that these organisms may be buffered from longer-term effects of thinning more than those in litter. Peck and Niwa (2004) found no difference in densities of soil detritivores between thinned and unthinned stands in the upper five cm 16-41 years after thinning. However, these organisms have relatively limited dispersal ability and will be slow to recover from negative effects (Pilliod and others, 2006).

Amphibians/Reptiles

No exclusively subterranean amphibians or reptiles occur in California

Birds

No exclusively subterranean birds occur in California.

However, burrowing owl, a species that nests in the underground burrows of other taxa, is likely to benefit from thinning treatments that reduce vegetation and improve foraging and nesting habitat for the species.

Mammals

Because most mammals that utilize subterranean habitat also inhabit the terrestrial landscape, the indirect effects are addressed in the ground-dwelling fauna section.

Herbivory

The use of herbivorous treatment methods is not expected to have substantial adverse effects on subterranean fauna therefore discussion at the level of the sub-guild is unnecessary.

<u>Ground-dwelling fauna</u>

Prescribed Fire

Invertebrates

In general, terrestrial mollusks are reliant on downed logs to avoid desiccation and only venture out during wetter times of the year. A study covering three national forests in the Pacific Northwest found that prescribed fires reduced the total weight of large downed wood (>9 inches in DBH) by 59% (Saab and others, 2006). Thus, prescribed fires that consume most of the coarse woody debris will depress many species of mollusk populations until downed wood begins to reaccumulate. One study found that mollusk species associated with old growth were less abundant in recently burned forests than forests not showing evidence of recent fire (Agee, 2001). Conversely, this study also found that the range-restricted mollusk, *Helminthoglypta talmadgei*, was more common in recently burned forest. Due to the poor dispersal abilities of mollusks, recolonization of burned forest is extremely slow and is dependent upon distance to the nearest refugium of unburned habitat (Dunk, 2004).

The indirect effects of prescribed fire on ground-dwelling arthropods are extremely variable considering the immense diversity of this guild. Variability amongst studies also exists because of the confounding effects of burn intensity and time since fire.

Immediately after a fire passes through an area, populations of detritivores in the leaf litter and under logs will be depressed due to the consumption of duff and downed wood. In riparian areas, bare ground may increase tenfold after a prescribed fire (Bêche and others, 2005). However, several studies have shown that species diversity and abundance can quickly rebound and exceed previous levels once the spring growing season begins (Force, 1981; Hutchins, 2005). This is most likely correlated with the increase in early-succession vegetation (Force, 1981). Not all species are affected equally by fire, though, and species compositional changes may occur with the change in habitat. For instance, Apigian and others (2006) found that in the first years following fire in a coniferous forest, common species became less abundant, while rarer species became more numerous.

Indirect effects of prescribed fire on predatory arthropods are variable and probably relate mostly to how they respond to structural habitat changes. Regionally these invertebrates should respond positively to small prescribed fires that diversify the forest structure (Pilliod, 2006). Niwa and Peck (2002) found that although species richness and diversity were not affected by prescribed fire treatments, the abundance of some species of spiders increased while others declined. In this study, populations of spider species that actively hunt their prey were greater in burned forests than in unburned control plots while more sedentary sit-and-wait spiders showed the reverse trend. Habitats structurally simplified by fire may allow actively hunting spiders to be more successful (Niwa and Peck, 2002). In a different study, Hutchins (2006) found that in both years following a prescribed fire arachnids were about half as numerous in treated plots as in control plots. Carabid beetle species appear to be more sensitive to effects of prescribed fire than spiders and authors have provided various reasons for this. Apigian and others (2006) hypothesized that a reduction in leaf litter may be responsible for post-fire declines in carabid beetle populations on their study plots, while Niwa and Peck (2002) believe that declines in carabid beetles on their plots were more likely due to the seasonal timing of the treatment where spring burns may have consumed the eggs and larvae.

In the short term, many invertebrate herbivores and pollinators may benefit from prescribed fire as increased light penetration increases succulent vegetation and dense annuals create a bountiful floral resource (M. Messler pers. comm.). In a Mediterranean ecosystem in Israel, bee diversity and abundance were greatest during the second year following fire, but then declined steadily over the first 25 years until gradually leveling off once pine forest had matured and restricted annuals and shrubs to forest openings (Potts and others, 2003). Fires might also benefit ground-nesting bees by clearing away the duff layer and providing them access to the soil (M. Messler pers. comm.). Butterfly abundance and diversity in the Sierra Nevada were found to be substantial greater in riparian and forested areas treated with prescribed fire than on control plots (Huntzinger 2003). Total area and density of sunlit patches were found to be the two most important factors contributing to these differences (Huntzinger, 2003). Huntzinger (2003) also found in the eastern Siskiyou Mountains of Oregon that fuel breaks along ridge tops promoted 13 times as many butterfly species than ridge tops without fuel breaks.

Amphibians/Reptiles

Many terrestrial amphibians require moist duff and coarse woody debris as cover objects to prevent desiccation and exposure to extreme temperatures (Pilliod and others, 2003). The loss of woody debris and duff due to prescribed fire will likely make these environments unsuitable for amphibians and depress their populations until these habitat elements are restored (Pilliod and others 2006). In Douglas-fir forests adjacent to talus fields in the Klamath Bioregion, high quantities of rotten logs and fine fuels were found to be important variables in predicting the presence of Del Norte salamander (*Plethodon elongatus*) (Major, 2005).

Since reptiles require access to sunlit areas where they may raise their body temperature, fires will probably be beneficial in that they create openings for basking. However, lizards and snakes may also lose large woody debris that is used for thermoregulation and protection from predators. Effects of fire on food are variable, but overall abundance of typical food items such as arthropods and rodents generally increases and may thus benefit reptiles. Fires may also increase connectivity for some species of reptiles by reducing shrubs and forests, which may inhibit movement and gene flow (Templeton and others, 2001). In an oak woodland study comparing before/after plots and control/impact plots, a small prescribed fire had no effect on western skink (*Eumeces skiltonianus*) abundance (Vreeland and Tietje, 2002).

Birds

Prescribed fire during the breeding season could result in direct mortality or reproductive failure to ground and shrub-nesting birds in particular. However, bird species that prefer open ground for foraging and nesting may benefit for a period of time from prescribed fires that convert shrublands to bare ground and create openings in dense coniferous forests (Pilliod and others 2006). Reduced ground cover after fire will increase the visibility of foods such as seeds and insects providing a benefit to ground-foraging birds until annuals and shrubs grow back (Pilliod and others 2006). This benefit in the ability of birds to detect food may be slightly offset by their increased vulnerability to predators. Furthermore, raptors that hunt for prey that are on the ground will benefit from a reduction in ground cover and shrubs and may increase in abundance after a site has burned (Lawrence 1966). As the flush of increased nutrients into the soil increases primary productivity, ground-foraging insectivores may continue to benefit for a few years after a burn. Hutchins (2005) found that arthropod abundance was substantial higher in coniferous forests one year after a prescribed fire, and she suggested that increased nest success of dark-eyed juncos (*Junco hyemalis*) on burned plots was due to increased feeding rates and nest attentiveness. Junco abundance between burned and unburned plots did not differ though (Hutchins, 2005), and so a study in oak woodland simply showing that prescribed fire did not increase junco abundance relative to a control plot (Vreeland and Tietje, 2002) may have missed the benefits on nest success from burning. After a fire some ground-nesters may have a more difficult time concealing their nests with the sparse vegetation available and may lose more nests to predators unless they can be more flexible in selecting nest sites (Hutchins, 2005). Burning sagebrush will increase suitable habitat for grassland ground-nesters such as long-billed curlew (*Numenius americanus*), horned lark

(*Eremophila alpestris*), and vesper sparrow (*Pooecetes gramineus*; Knick and others 2005).

Mammals

Cover and food are the two most critical habitat elements for small mammals (Pilliod and others, 2006). In the short term prescribed fires generally reduce shrub cover and increase foods, which may be beneficial to generalist rodents, but negatively affect shrub specialists. For example, Lawrence (1966) found that chaparral species such as piñon mouse (*Peromyscus truei*) and California mouse (*P. californicus*) declined in number while the generalist deer mouse (*P. maniculatus*) increased following prescribed fire. The degree to which fire affects recolonization depends upon the spatial pattern and extent of the burn. Large burns with no unburned refugia will take much longer to be repopulated by small mammals than small or patchy burns. In an oak woodland study, small prescribed fires had no effect on the abundance of four rodent species – dusky-footed woodrat (*Neotoma fuscipes*), piñon mouse, brush mouse (*P. boylii*), and California mouse – comparing before/after plots and control/impact plots (Vreeland and Tietje, 2002). This differed though from a large wildfire in chaparral and coastal sage scrub where three species common to mature shrub – dusky-footed woodrat, California mouse, and cactus mouse (*Peremicus*) – were seldom captured in the burned area and then only near the edge (Schwilk and Keeley, 1998). Deer mouse abundance, however, was positively correlated with distance from edge.

Ungulate populations generally increase after fires in response to improved quality and quantity of browse (Smith, 2000; Pilliod and others, 2006). During the first few years after a fire removes woody shrubs, mule deer (*Odocoileus hemionus*) populations may increase in response to increased grasses and forbs (Kie and others, 2003). Five to ten years after a fire, deer populations may peak in shrublands and forested environments when young shrubs provide succulent browse (Kie and others, 2003). Canon and others (1987) found that elk (*Cervis elaphus*) preferred forage in burned aspen stands over forage in unburned aspen stands. They attributed this to greater foraging efficiency in the burned stands where elk ate at a faster rate and traveled less between feeding bouts (Canon and others, 1987). Burning in mosaic patterns may further benefit ungulates by increasing food availability while retaining thermal cover and concealment from predators and humans (Kie and others, 2003). Mule deer benefit from edge environments where they can fulfill all of their daily requirements within a small home range.

Mammalian carnivores may benefit from prescribed burns in the short term through increased foraging opportunities on prey such as small mammals that may be easier to catch in the absence of cover and in the long term because the prey population often increases in the years following a fire due to new vegetation growth (Smith, 2000). Prescribed fires create edges that may also provide good foraging opportunities as the area recovers, as well as increasing other foods eaten by some carnivores such as fruits and succulent grasses (Johnson and Landers, 1978). Large burns may have different impacts on individual carnivore species. Some forest carnivores, such as the American marten (*Martes americana*) and fisher (*Martes pennanti*), tend to avoid areas with little overhead cover, probably to avoid predation themselves; other species, such as coyote (*Canis latrans*) and bobcat (*Felis rufus*), may have a positive response to large burns as they are often associated with open habitats (Buskirk and Zielinski, 2003). Prescribed fires may have negative effects on mammalian carnivores that use structures such as downed logs and snags for resting and denning as these may be consumed in the fire (Pilliod and others, 2006). These effects could be minimized by using cooler prescriptions in forested areas that would not result in complete consumption of large downed woody debris. Conversely, fires may also create denning and resting structures as they often help generate cavities in logs and trees that may subsequently be used by wildlife (Shaffer and Laudenslayer, 2006) and may lead to recruitment of small to medium sized downed woody debris as a result of mortality in suppressed and intermediate crown classes. Black bears (*Ursus americana*) require thermal and escape cover and may avoid areas with large homogeneous underburns (Cunningham and Ballard, 2004). Burning in mosaic patterns will likely benefit most mammalian carnivores through improved foraging opportunities and the creation of new structures, which can provide thermal and escape cover.

Thinning

Invertebrates

Clearing of coastal sage scrub has been shown to affect arthropod community composition substantially by reducing vegetative complexity and by promoting invasion by exotic arthropods, with a concomitant loss of native species (Longcore, 2003). Argentine ant (*Linepithema humile*) in particular has a devastating impact on native arthropod diversity (Human and Gordon, 1997, Kennedy, 1998; Suarez and others, 1998) and a ripple effect on species that prey on them (Suarez and others, 2000).

Forest-floor detritivores (millipedes, isopods, mites, *etc*.) and decomposers (termites, beetles, ants, *etc*.) may be affected severely by disruption and loss of litter and down wood, as is likely to occur with slash removal (Gunnarsson and others, 2004). While these animals are able to colonize suitable areas quickly, it apparently takes a very long time for the necessary habitat elements to accumulate sufficiently for their populations to recover from such disturbance (Peck and Niwa, 2004).

Fuel reduction treatments appear to have mixed effects on predatory invertebrates. Terrestrial spiders and beetles are the best studied (Pilliod and others, 2006). In one study, individual carabid species responded differently to thinning, with some increasing and some decreasing such that overall abundance and diversity were unaffected (Peck and Niwa, 2004). In the same study, hunting spiders were more numerous in thinned stands and sheet-web spiders more abundant in unthinned stands. Villa-Castillo and Wagner (2002) found no difference in ground beetle species assemblage between ponderosa stands 4-10 years after thinning and control stands. Longcore (1999) found that disturbed coastal sage scrub sites had lower invertebrate predator diversity than undisturbed sites. Site management history and size of treatment area may be significant factors influencing terrestrial arthropod responses to thinning (Apigian and others, 2006).

Indirect effects of thinning on invertebrate herbivores and pollinators appear to be mostly positive. Increased solar radiation penetrating to the ground promotes vegetative growth and flowering, benefiting butterflies and moths during their larval and adult stages, respectively (Ross, 1995; Waltz and Covington, 2004). However, disturbance can favor invasive plants that may displace Lepidopteran host species (Huntzinger, 2003).

Amphibians/Reptiles

Most terrestrial amphibians require a heavy component of duff, litter, and down wood for cover and moisture; while they may benefit initially from slash created by thinning, its later removal will harm them. Overstory canopy is also important to forest amphibians (Martin and McComb, 2003) and is not targeted for removal in the VTP. Densities of some amphibians' prey, notably ants, are higher in recently disturbed areas, and thinning may result in increased numbers of those amphibian species (*e.g.*, toads) (Corn and Hossack, Kirkland and others, 1996; Bull, 2006).

Almost nothing is known about the effects of thinning on reptiles (Pilliod and others, 2006). Since different species have different habitat requirements, they will respond differently to any given treatment, but most species will benefit from the warmer, drier conditions created by thinning. Many snakes likely will benefit from treatments that open the canopy and increase populations of terrestrial rodents (see small mammals, below). A few species inhabit litter, logs, *etc.* in closed-canopy forest and will be affected negatively by treatments that remove these habitat features. Most reptiles of forested landscapes occupy discrete patches such as wet meadows and rock outcrops that likely will be excluded from treatment.

Birds

Thinning appears generally to have no or a positive effect on terrestrial birds. Siegel and DeSante (2003) found no difference in densities of ground-nesting birds between thinned and unthinned mixed conifer stands in the Sierra Nevada five to eight years after treatment. They also found no difference in nest success except that of dark-eyed junco (*Junco hyemalis*), which was higher in the thinned stands. Hagar and others (1996) found higher breeding-season densities of dark-eyed junco and higher winter densities of winter wren (*Troglodytes troglodytes*) in thinned Douglas-fir stands in Oregon five to fifteen years after treatment than in unthinned stands of the same age. Haveri and Carey (2000) also found higher winter densities of winter wren as well as song sparrow (*Melospiza melodia*) on thinned plots; they attributed this to higher vegetation densities (hence more foraging substrate) on the ground. Aigner and others (1998) compared thinned and unthinned oak-pine woodland and found that ground-nesting and/or –foraging species increased in abundance on the thinned plots, associated with brush piles.

Mammals

Small mammals may repopulate disturbed areas very quickly, with generalists preferring early seral stages and specialists later ones (Fisher and Wilkinson, 2005). Sullivan and others (2001) compared unthinned, thinned, and old-growth lodgepole pine (*Pinus contorta*) stands in Canada and found overall small mammal abundance higher (comparable to that in old-growth stands) in low-density thinned stands than in unthinned stands ten years after treatment. In western Washington, thinned second-growth stands had more small mammals than unthinned legacy retention stands, but neither community resembled that of old-growth (Wilson and Carey, 2000). Some species (*e.g.*, chipmunks and some deer mice) are likely to increase after thinning in conifer forests, but others (*e.g.*, red-backed voles [*Myodes* sp.] and snowshoe hare [*Lepus americanus*]) probably will decrease (Bull and Blumton, 1999; Wilson and Carey, 2000; Woolf, 2003). Many forest-dwelling small mammals are dependent on features such as truffles and soft logs usually associated with cool, moist conditions; thus, treatments such as heavy thinning that result in warmer, drier conditions will affect these species negatively even if the soil is not disturbed and logs are not removed (Lehmkuhl and others, 2004; Meyer and others, 2005). Retention of unthinned patches within thinned stands may help maintain some small mammal populations.

Reduction in canopy cover (short of complete removal) seems to have relatively little effect on mesocarnivores (K. Slauson, pers. comm.). More critical is retention of key habitat elements including large trees (especially hardwoods), snags, and logs (Buskirk and Powell, 1994). Effects of treatment on key prey species are also important. Fisher and marten forage primarily on the ground when it is snow-free and may benefit from late spring to late fall from increases in rodent and grouse populations responding to vegetative growth resulting from thinning. However, they depend on arboreal prey, especially squirrels, the rest of the year, and those species may be affected negatively by thinning, especially if cavities and brooms are removed (see small mammal section above). Intact canopy cover reduces snow buildup on the ground and keeps terrestrial prey accessible longer. Thus, the mosaic of thinned and unthinned patches that will result from the VTP should benefit fisher and marten, provided that patches are large enough to sustain prey populations and that legacy features are retained in thinned patches.

Among large carnivores, black bear (*Ursus americanus*) is perhaps the most likely to be affected substantial by fuel reduction treatments due to its abundance, distribution, diet, and habitat use (Pilliod and others 2006). This species relies heavily on down wood (as a foraging substrate), dense thickets (for cover), and large-diameter hollow logs (for denning) in mature forest landscapes (Bull and others, 2000, 2001); thus, treatments that reduce these habitat elements are likely to affect black bear negatively. It may be easier to retain such elements with mechanical and manual treatments than with fire, but thinning may result in vegetation structure unfavorable to black bear (Mollohan and others, 1989).

Ungulates prefer a mosaic of open areas and forest cover (Pilliod and others 2006). Fuel reduction treatments, alone or in combination, often improve foraging conditions for ungulates (Riggs and others, 1996; Demarais and Krausman, 2000) but retention of patches of dense cover at least 0.04 ha in size may be required (Chambers and Germaine, 2003). Fuel reduction has been shown to reduce use of day beds for several years (Germaine and others, 2004). Ungulates are usually limited by winter forage, so appropriate treatments on their wintering grounds are likely to be more beneficial to them than those on their summer grounds (Hobbs and Spowart, 1984). Improved winter forage may outweigh loss of cover in importance to deer in some cases (DePerno and others, 2002), but loss of thermal and canopy cover in wintering areas can make stands unusable by deer, especially in areas of heavy snowfall (Armleder and others, 1989).

Herbivory

The widespread adverse effects of over-browsing by artificially large native ungulate populations are well documented. Selective browsing pressure on certain understory and ground-cover plants causes changes in relative abundance and dynamics within the plant community (Côté and others, 2004). This has cascading effects on terrestrial animals ranging from mollusks to other mammals and can cause the complete loss of species from an ecosystem. Repeated vegetation treatment using livestock has the potential for similar effects if applied to native vegetation. Use of livestock in the VTP will be managed carefully and applied primarily to control invasive vegetation.

Invertebrates

Habitat modification resulting from prescribed herbivory may favor some invertebrate species and be a detriment to others. Some species may suffer negative impacts as a result of soil compaction. Those invertebrate species that are associated with dung may benefit from droppings left behind after livestock application. Dung provides import habitat for foraging and the rearing for a number of invertebrates such as flies, beetles and annelid worms. Many of these species play an important role in nutrient cycling in the habitats in which they occur.

Amphibians/Reptiles

Habitat modification resulting from the application of prescribed herbivory is likely to favor most reptiles and be detrimental to most amphibians. Species that burrow in the soil are likely to suffer as a result of soil compaction.

Birds

Effects of livestock grazing on neotropical migratory birds vary by habitat but appear to be predominantly negative. In a review paper, Bock and others (1993) found that within grassland, shrubsteppe, and riparian habitats, some species respond positively, some negatively, and some inconsistently. Negative responses predominate in short-grass, shrubsteppe, and riparian habitats, while positive responses predominate in tall-grass habitats, which evolved with grazing by large herds of ungulates. Species that depend on lush, ungrazed, herbaceous ground cover for nesting and/or foraging are most at risk. No information was available on bird responses to grazing in coniferous forests.

Browsing pressure on shrubs diminishes seed production, and this may reduce population levels of granivorous birds. Deveny and Fox (2006) found that abundance of rodents, especially deer mice, was inversely related to browsing intensity in chaparral.

Mammals

Contrary to expectation and popular belief, grazing by livestock can have beneficial consequences to native ungulates. In a study of the effects of sheep grazing in conifer plantations, Rhodes and Sharrow (1990) found that grazed areas had more succulent forage in the spring and their forage was of better quality in the fall. However, overall phytomass of browse and forbs (but not of graminoids) was reduced by grazing.

<u>Shrub-dwelling fauna</u>

Prescribed Fire

Since prescribed burning is usually designed to reduce shrub cover, wildlife that live or nest in shrubs or are reliant on shrub cover will be affected for several years by this treatment. Indirect short-term effects of this treatment include increased predation due to lack of cover, increased sunlight, and increased edge. In the long term, though, fires are a necessary part of the natural cycle in most shrub habitats, resetting the system to an earlier seral stage. Attempting to exclude fire from these habitats may lead to an unnaturally high proportion of senescent shrubs that may not provide critical habitat elements necessary for wildlife, and an accumulation of fuels which may eventually burn unnaturally hot and uniformly. Natural fires in shrublands often leave pockets of unburned habitat as refugia that allow swift recolonization of the habitat as the vegetation reestablishes (Smith, 2000).

Invertebrates

Little has been published about the indirect effects of burning shrublands on most invertebrate taxa. In a chaparral ecosystem, Force (1981) found that insect diversity and abundance were greatest the first year following a wildfire, but then declined slowly over the subsequent two years. These insect indices closely paralleled plant diversity and abundance and it was believed that the insects emigrated from unburned areas. After a much larger chaparral wildfire, Moldenke (1977) found that pollinator diversity and abundance were much lower on burned than unburned plots. This would seem to indicate that burning in a mosaic pattern and leaving unburned refugia could enhance insect recolonization.

Amphibians/Reptiles

Basking in sunlight is an important thermoregulatory behavior for reptiles, so reduction of foliar cover in shrublands may generally be beneficial for this guild although some structure is still necessary to provide cover (Lillywhite, 1977). In a study comparing mature and burned chaparral to grassland, Lillywhite (1977) found that abundances of five lizard species – western fence lizard (*sceloporus occidentalis*), side-blotched lizard (*Uta stansburiana*), western whiptail (*Cnemidophorus tigris*), western skink (*Eumeces skiltonianus*), and coast horned lizard (*Phrynosoma coronatum*) – were highest in recently burned chaparral, moderate in mature chaparral, and lowest in grassland. Burned branches of chaparral shrubs can provide important perching structure for lizards where they may bask and observe the approach of predators from an elevated vista (Lillywhite and North, 1974).

Birds

For most birds that are specialist shrub-dwellers, the reduction of structure and particular foods following prescribed fires will likely depress populations until shrub structure returns. In the Sierra Nevada foothills, the chaparral adapted species – California quail (*Callipepla californica*) and California towhee (*Pipilo crissalis*) – were the most adversely affected by a prescribed fire (Lawrence 1966). In the short term, the species that fare best after prescribed fires in shrubland communities are generalist species that are better adapted to more open spaces, such as western scrub-jay (*Aphelocoma californica*) and mourning dove (*Zenaida macroura*) (Moriarty and others, 1985). In sagebrush habitats, large homogeneous fires are likely to cause substantial declines in populations of sagebrush-adapted birds (Knick and others, 2005). When sagebrush removal treatments are repeated, the probability of sagebrush recovery is low, thus prohibiting populations of sagebrush obligates from recovering (Knick and others 2003). Smaller patchy fires have been found to have less of an impact on songbirds such as Brewer's sparrow (*Spizella breweri*) that can use unburned patches until sagebrush reestablishes (Peterson and Best, 1987). Sagebrush obligates have also been found to decline in abundance when juniper trees encroach and crowd out sagebrush (Knick and others, 2003). Thus, burning off encroaching juniper would likely benefit these birds in the long-term so long as sagebrush is allowed to return as the dominant vegetation-type (Knick and others, 2005). Furthermore, in mountain shrublands surrounded by forested areas, disturbances such as fire are essential to prevent tree encroachment and maintain the brush fields in which shrub-dwelling species occur (Burnett and Nur, 2007).

Mammals

Decreased shrub densities as a result of prescribed fire are likely to result in short-term adverse impacts to mammalian species that require shrubs for cover, denning, foraging habitat, or breeding habitat.

Thinning

Invertebrates

Invertebrates that are specifically associated with shrubs are likely to suffer adverse impacts as a result of thinning that targets shrub cover.

Amphibians/Reptiles

As with other shrub-swelling species, herpetofauna that require shrub cover are likely to be adversely affected by thinning treatments that target the shrub layer.

Birds

Alexander and others (2007) found that shrub thinning in small treatment areas with retention of shrub patches did not reduce abundance of shrub-dwelling birds of oak woodland and chaparral habitats zero to six years after treatment. Two bird species associated with edges, open subcanopy, and/or large cavity trees were more abundant in treated plots and none of the 12 species studied was less abundant. Thus, small-scale, patchy thinning of shrubs may have no or a positive effect on birds. Since tree thinning promotes shrub growth, it follows that it should benefit shrub-nesting birds, and this was documented by Siegel and DeSante (2003), who found much higher densities and, for one species, more nests in thinned plots. Shrub-associated birds either increased or showed no change as a result of thinning that created brush piles in oak-pine woodland (Aigner and others, 1998). However, deleterious edge and fragmentation effects on birds of chaparral and other shrub habitats are well documented; Bolger and others (1997) found a number of species reduced near edges and in fragmented stands in shrub habitat, and Stralberg (2000) found that migrants and chaparral-associated birds decreased with proximity to stand edge. Further, Potts (2006) found that birds are eight times more likely to be found in prescribed fire areas than in masticated areas due to the lack of plant skeletons in masticated areas and the related effects on perch/nest site availability, predator movement and microclimate.

Mammals

Thinning treatments that remove shrub cover could negatively impact small mammals that rely on them for cover from predators, foraging habitat, or breeding habitat. Conversely, species that prefer open habitats may benefit from loss of shrub cover and forage material provided by fruiting shrubs, grasses and forbs that may become established post-treatment (ODF, 2008). In general, habitat generalists tend to dominate early successional stages post-burn while specialist species dominate later (Fisher and Wilkinson, 2005).

Ungulates such as deer and elk require dense shrub and tree thickets for thermal cover, to hide from predator, for daybeds, and for fawning. They also utilize shrubs for forage material. Thinning generally increases both the quality and quantity of forage material for ungulates, resulting in a beneficial effect from treatment. However, the retention of patches of dense cover is also important as treatments that remove such cover could result in a decline in habitat suitability for ungulates (Demarais and Krausman, 2000). If large areas of forest cover are removed as a result of thinning, wintering ungulates may be forced to lower elevations (Henjum, 2006).

Herbivory

Browsing pressure on shrubs may have long-term implications on floral and faunal community structure and composition. Deveny and Fox (2006) found that unbrowsed chaparral shrubs produced many more seeds than browsed shrubs, resulting in a larger seed bank. Clearly, a reduced seed bank may have lower shrub replacement potential, which could jeopardize long-term habitat availability for shrub-dependent wildlife.

Invertebrates

Because most prescribed herbivory applications will remove shrubs, invertebrates they require shrubs for any of their life stages are likely to be displaced as a result of habitat loss.

Amphibians/Reptiles

No exclusively shrub-dwelling amphibians or reptiles occur in California.

Birds

Purcell and Verner (1997) compared grazed and ungrazed oak-pine woodland and found higher California towhee densities but lower towhee productivity on the ungrazed plot. Grazing reduced overall plant cover but increased cover of the oak species in which towhee nests were most successful; towhees apparently were attracted to the greater overall cover of the ungrazed plot, despite the higher nest predation rate there. This result suggests, ironically, that grazing was beneficial to this species by lowering its density (and, presumably, density-dependent predation). Broader implications are unknown, but it is safe to say that most shrub-nesting birds will be less attracted to a site in which understory and ground cover have been reduced and that density may not be the best measure of population health.

Mammals

As with thinning treatments that remove shrubs, herbivory treatments that remove shrubs are likely to impact small mammals that utilize them for cover, predator avoidance, foraging, or breeding will suffer adverse impacts as may ungulates that utilize shrubs for browse, thermal cover, predator avoidance, daybeds and fawning.

<u>Arboreal fauna</u>

Prescribed Fire

Invertebrates

Disturbances such as fire in forested habitats may weaken some trees due to bole char, crown scorch, and fine root mortality, which may predispose the trees to an infestation of bark and wood boring insects (Bradley and Tueller, 2001; Pilliod and others, 2006). Several species of insects, mostly beetles and flies, have been shown to be attracted to freshly burned forests where they may oviposit into burned wood (Bradley and Tueller, 2001; Swengel, 2001; Machmer, 2002; Apigian and others, 2006). In a study looking at the effects of prescribed fire, Bradley and Tueller (2001) found that the probability of bark beetles infesting Jeffrey pines (*Pinus jeffreyi*) was 25 times greater in burned plots than in unburned control plots. In addition, they found that bole char height and percent crown scorch were both positively correlated with the probability that Jeffrey pine would be infected by the Jeffrey pine beetle (*Dendroctonus jeffreyi*) and/or red turpentine beetle (*D. valens*). In a different study, the probability of ponderosa pine (*Pinus ponderosa*) being attacked by beetles in the genus *Dendroctonus* or *Ips* and the probability of subsequent mortality over three years increased with percent crown scorch (McHugh and others, 2003).

Amphibians/Reptiles

Because prescribed fire applied under the proposed program is not expected to burn large trees, impacts to reptiles and amphibians that utilize arboreal habitats are not expected to occur at a significant level.

Birds

In general, the indirect effects of prescribed fires on primary cavity-nesting birds (birds that excavate their own cavities for nesting) are negligible to slightly positive for low intensity fires (Saab and others 2006) and become increasingly beneficial for some species when fire gets into the canopy and kills off large numbers of trees (Hutto, 1995; Saab and others, 2004). In forested ecosystems, primary cavity nesters often act as keystone species that provide an important structural resource (cavities) for a number of other species (Martin and others, 2004). In forest types of the Pacific Northwest, 25-30% of vertebrates use cavities for reproducing or resting (Bunnell and others, 1999). In the VTP area there are 17 species of birds – primarily woodpeckers, but also chickadees and nuthatches – that excavate cavities in trees. Primary cavity nesters seek trees and snags with decayed heartwood in which to excavate their cavities (Bunnell and others, 1999). Bark beetles are often attracted to forests shortly after trees are burned and weakened by prescribed fire (Bradley and Tueller, 2001). In a mutually beneficial relationship, these beetles bore into the trees, carrying pathogenic fungal spores with them in mycangium (invaginations in the exoskeleton); the combination of the beetle activity and fungal growth may overcome the tree's defenses and lead to heart rot (Paine and others, 1999). This combination of factors makes burned trees a favored resource for woodpecker foraging and nest cavity excavation. Saab and others (2004) found that three to five years after a fire the probability of a cavity being occupied decreased substantially. This decrease occurs because snags begin to deteriorate and fall down, wood-boring beetles decrease, and the numbers of nest predators increase (Saab and others, 2004). Fires can also adversely affect primary cavity nesters by altering the micro-climate of cavities by enlarging their openings or creating extra openings, which may make the cavity unsuitable for nesting or roosting and thus cause displacement (Shaffer and Laudenslayer, 2006).

The abundance of cavities available to many secondary cavity nesters – birds that use preexisting cavities – is often tied directly to the success of primary cavity nesters (Martin and others, 2004). Although some species such as wood duck (*Aix sponsa*) and spotted owl (*Strix occidentalis*) can nest in tree cavities created through other means (e.g., broken branches, broken tops, and cracks), the majority of secondary cavity nesters are reliant upon primary cavity nesters such as woodpeckers to excavate cavities (Martin and others, 2004). Twenty-two species of birds within the VTP area are obligate secondary cavity nesters and at least six others are facultative cavity nesters. In the short term, prescribed fires may reduce cavities in an area by burning some snags already containing cavities (Dwyer and Block, 2000). However, as woodpeckers excavate new nest cavities in the years following a fire, the number of unoccupied cavities available for secondary cavity nesters should increase above the number present before the fire. Although nest cavities may increase after a prescribed fire, the habitat may still be unsuitable for some secondary cavity nesters if appropriate foraging habitat is unavailable. Dwyer and Block (2000) found that the abundance of secondary cavity nesting insectivores varied substantially one year after an understory burn and theorized that differences in foraging methods may have been a primary factor in determining a species' response to fire. For instance, bark-gleaning (e.g., Pygmy Nuthatch [*Sitta pygmaea*]) and foliage-gleaning species (e.g., Mountain Chickadee [*Poecile gambeli*]) typically decline in abundance following fires (Block and Dwyer, 2000, George and Zack, 2003), which may be due to a reduction of bark and foliage. Bluebirds, on the other hand, have been found to increase in many post-fire settings (Raphael and others, 1987; Block and Dwyer, 2000). This may be partially due to an increase in cavities, but may also be related to increased visibility of the ground, as foraging bluebirds often perch or hover in open areas and then drop to the ground to capture insect prey (Guinan and others, 2000; Power and Lombardo, 1996). Secondary cavity nesters that prefer nesting in open areas such as western bluebirds (*Sialia mexicana*) and violet-green swallows (*Tachycineta thalassina*) will be the most likely species to benefit from prescribed fire (Purcell and Stephens, 2005).

Indirect effects on arboreal canopy birds will likely depend on the forest type that is treated. Many species breeding in the canopy of a coniferous forest will probably be unaffected by low-intensity understory burns. One study looking at the effects of thinning and prescribed fire in a giant sequoia forest found that bird species abundance in the treated plots was variable in the upper canopy and did not differ substantial from the untreated control plots (Kilgore, 1971). In the understory, though, western wood-pewees (*Contopus sordidulus)* nested and foraged in greater numbers after the understory had been reduced (Kilgore, 1971). Some authors have suggested that flycatchers such as the western wood-pewee and olive-sided flycatcher (*Contopus cooperi*) may benefit and even increase in number in recently burned forested environments due to a greater availability of perches and enhanced visibility for spotting and capturing prey (Kilgore, 1971; Altman and Sallabanks, 2000). Meehan and George (2003) found that the presence of olive-sided flycatcher was positively correlated with recently burned forest. However, they also found that over both years of the study, nest success was 50% greater in early seral stage forest than in recently burned forest (Meehan and George, 2003). The authors attributed this increased nesting success rate to increased aerial arthropod biomass (primarily beetles and termites) and a greater peak foraging rate in the unburned forest (Meehan and George, 2003). This suggests that indirect benefits due to disturbances such as prescribed fire may increase over time for aerial insectivores. Many hardwood forests currently suffer from fire suppression where fire intolerant conifer species (e.g., Douglas-fir [*Pseudotsuga menziesii*] and white fir [*Abies concolor*]) outcompete native trees. Aspen forest mixed with riparian vegetation contains the highest bird diversity in the Sierra Nevada, and prescribed fire has been identified as an effective tool at reducing encroaching conifers and maintaining aspen health (PRBO white paper).

Mammals

Indirect effects of prescribed fire on arboreal rodents are mostly negative for arboreal squirrels and relatively unknown for tree voles. Although prescribed fire will primarily be constrained to the understory, all three species of native arboreal squirrels in the VTP area – Douglas squirrel (*Tamiasciurus douglasii*), western gray squirrel (*Sciurus griseus*), and northern flying squirrel (*Glaucomys sabrinus*) – forage extensively on the forest floor for sporocarps of hypogeous fungi (i.e., truffles; Steinecker and Browning, 1970; Pyare and Longland, 2001) and other foods (e.g., acorns, conifer seeds, invertebrates; Wells-Gosling and Heaney, 1984, Carraway and Verts 1994, Steele, 1999). In a study examining prescribed fire effects one to two years after the burn, Meyer and others (2005) found that truffles were substantial reduced in number, biomass, and richness on burned plots compared to unburned control plots; thinning plots before burning further reduced these truffle metrics. Leaf litter depth, which has been linked to truffle abundance (North and Greenberg, 1998), was substantial reduced on plots treated with fire and/or thinning (Meyer and others, 2005) and was the only factor that explained the presence or absence of flying squirrels in burned forests (Meyers and others, 2007). Reduction of truffles following prescribed fire could have severe consequences for northern flying squirrels as truffles comprise a significant part of their diet (Hall 1991), and flying squirrel density has been found to be positively correlated with truffle frequency (Waters and Zabel, 1995). Fire may also be detrimental to Douglas squirrels which cache food on the ground in “middens.” Middens can be critical to over-winter survival (Smith and others 2003), and if consumed by prescribed fires, may cause these squirrels to perish from starvation. Furthermore, prescribed fire generally causes substantial reductions in shrub cover, which may increase the risk of predation for rodents during foraging activities (Pyare and Longland, 2002). Conversely, all three of these arboreal squirrels often use tree cavities as den sites (Ingles, 1965, Bakker and Hastings, 2002), and thus may benefit from prescribed fire over time as woodpeckers and other natural processes create more cavities. Although no studies have been conducted to determine the effects of prescribed fire on tree voles (*Arbormius longicaudus* and *A. pomo*), habitat use should be relatively unaffected by low-intensity prescribed fires since tree voles rarely descend from trees and build their nests on branches out of needles and twigs (Smith and others, 2003). Prescribed fires such as pile and jackpot burning may be beneficial to tree voles by reducing the risk of a stand-replacing wildfire. If fire, smoke, or heat gets into the canopy though, this could disrupt the micro-climate around nest trees and potentially cause abandonment. Although little is known about the habitat requirements necessary for dispersal, tree voles are known to occasionally disperse on the forest floor and so a reduction in shrub cover may increase the risk of predation.

Little has been published documenting the indirect effects of prescribed fire on bats. However, current understanding of habitat selection by bats suggests that most of the changes caused by prescribed fire are beneficial. Woody structures used for roosting are essential habitat elements for many bat species in forested environments (Hayes, 2003). Roosts provide protected shelters for resting, raising young, and hibernating (Hayes, 2003). Snags with sloughing bark and cavities and large-diameter trees with basal hollows are commonly used by bats for roosting (Gellman and Zielinski, 1996; Hayes 2003). Although prescribed fires may burn up some snags, they also help create new snags and basal hollows (Finney, 1996; Bradley and Tueller, 2001; Saab and others, 2006; Shaffer and Loudenslayer, 2006), which bats can then use for many years after the burn. Furthermore, woodpecker cavities – which may increase dramatically after fires (Saab and others, 2004) – have been shown to be important for some species of roosting bats (Kalcounis and Brigham, 1998; Bonar, 2000). In a study examining indirect effects of prescribed fire on bats, Boyles and Aubrey (2006) found that all 23 bats fitted with radio transmitters roosted everyday on a burned plot, though many of the bats had been captured on a road that separated the burned and an unburned plot. Boyles and Aubrey (2006) also found that canopy light penetration was substantial greater on the burned than unburned plot; these authors and others have suggested that day roosts with good sun exposure are preferentially selected by bats for thermoregulatory purposes (Waldien and others, 2000; Hayes, 2003). Warm roosts are particularly important for females during the reproductive period, as low ambient temperatures have been linked to low reproductive success (Lewis, 1993). Prescribed fires may also improve foraging by bats by reducing "clutter" (twigs, leaves, shrubs, small trees, etc.) in interior forest and thus enabling bats to more easily maneuver and echolocate insect prey (Brigham and others, 1997; Hayes, 2003).

Thinning

Invertebrates

Bark- and wood-boring insects (primarily beetles and wasps) are generally viewed unfavorably by forest managers, though they provide an important source of food for many animals, create habitat for cavity dwellers by killing trees, and are themselves valid elements of biodiversity. Dense stands are more susceptible to "infestation" (*i.e.*, more suitable for borers) than open stands because trees in dense stands are often stressed from competition and disease and thus vulnerable to attack by these insects. Therefore, treatments that improve tree condition, as thinning generally is thought to for the unharvested trees, affect borers negatively. However, site disturbance caused by thinning can itself stress trees and result in short-term increases in borer populations. Machmer (2002) and Apigian and others (2006) found *more* borers in thinned stands during the first year after treatment than in control stands. Borer populations in treated stands may take some time to diminish; Sanchez-Martinez and Wagner (2002) found no difference in endemic bark beetle abundance between control stands, thinned stands 4-11 years after treatment, and thinned and burned stands three to four years after treatment. Thus, thinning does not appear necessarily to be a prescription for reducing boring insect densities in the short term.

Amphibians/Reptiles

Thinning treatments are not likely to remove many large trees or have any significant impacts on amphibians or reptiles that utilize arboreal habitats.

Birds

Effects of thinning on forest raptors will depend on the species in question. Some raptors, including buteos, eagles, falcons, and large owls, prefer open forest structure in which they can maneuver and spot prey at a distance and often forage in clearings and meadows where terrestrial prey is abundant. However, large snags and trees must be present in the vicinity for nesting. Other species, including the smaller accipiters and owls, prefer denser stands that offer cover and support aerial prey populations and in which large raptors are absent. Yet others (*e.g.*, Northern goshawk [*Accipiter gentilis*]) prefer closed canopy, large trees, and open understory (Reich and others, 2004). Thus, thinning, no matter how it is done, can be expected to benefit some raptors and harm others. A diversity of treatments and vegetative structure at the landscape level will be necessary for achieving and/or maintaining high raptor diversity.

Effects of thinning on cavity-nesting birds (both primary and secondary) will depend primarily on the quantity of large-diameter snags removed. Non-selective treatment methods such as chaining that knock down snags as well as trees are likely to harm these birds (and other animals such as flying squirrels that use cavities, which often are a limiting resource). Conversely, manual treatments can be much more selective and leave snags in place. Some species, including pileated woodpecker (*Dryocopus pileatus*), forage to a large extent on down wood and will be affected negatively from its removal as well (Bull, 1987); pileated woodpecker was the only cavity nester found more in unthinned than thinned stands by Siegel and DeSante (2003). Hairy woodpecker (*Picoides villosus*) responded favorably to commercial thinning where large conifers, snags, and slash were not removed, perhaps because of increased foraging substrate and stand openness (Hagar and others, 1996). Hairy woodpecker also responded favorably to thinning in Hayes and others (2003) study. Several cavity nesters had higher nest success on thinned plots in Siegel and DeSante's (2003) study. Northern pygmy-owl (*Glaucidium gnoma*) increased after thinning with retention of cavity trees in oak-pine woodland (Aigner and others, 1998), presumably because of increased foraging opportunities in the openings created. Thinning alone may be better for cavity nesters than thinning followed by burning (Bull and others, 2005), although two species preferred thinned and burned plots to thinned-only and control plots in George and Zack's (2003) study.

Effects of thinning on other arboreal birds vary by species and forest type. Species positively associated with open subcanopy may benefit from thinning of that layer; bark-foraging species may benefit from thinning if slash is not removed; and species associated with hardwoods may benefit from thinning of conifers (Hagar and others 1996). Conversely, species of dense, closed-canopy forest are likely to suffer from thinning (Hagar and others 1996). Siegel and DeSante (2003) found most canopy-nesting birds to be more abundant and, in two cases, more productive on thinned than unthinned mixed-conifer plots, but two species were more abundant on the unthinned plots. Aigner and others (1998) had similar results in oak-pine woodland, with several species increasing after thinning and two decreasing. George and Zack (2003) and Hayes and others (2003) found nearly equal numbers of species increasing and decreasing in response to thinning. Beedy (1981) found more birds, especially understory gleaners and salliers, in open- than closed-canopy forests. Pacific-slope flycatcher (*Empidonax difficilis*), Hutton's vireo (*Vireo huttoni*), golden-crowned kinglet (*Regula satrapa*), brown creeper (*Certhia americana*), and black-throated gray warbler (*Dendroica* *nigrescens*) are among the arboreal species that consistently appear to be affected negatively by thinning (Haveri and Carey, 2000; George and Zack, 2003; Hayes and others, 2003). Thus, many arboreal birds favor less-dense forest stands, although some species are dependent on dense, closed-canopy forest and will require retention of unthinned patches.

Mammals

Little information is available on responses of bats to thinning, but bats of treed habitats are dependent on roost sites such as loose bark and cavities that are characteristic of mature stands. Additionally, spacing between trees may facilitate bat flight, and well-developed shrub and herbaceous layers may support insects on which bats feed. Pallid bat (*Antrozous pallidus*) feeds primarily on terrestrial arthropods that in turn require leaf litter and other ground cover. Studies suggest that bat densities are highest in old-growth forest; lowest in dense, second-growth stands; and intermediate in thinned stands in which large-diameter snags and trees have been retained (Perkins and Cross, 1988; Thomas 1988; Humes and others, 1999). Thus, thinning of second growth can be expected to benefit bats if it does not remove ground cover or roost sites.

Arboreal rodents are typically dependent on characteristics associated with mature forest, including cavities, brooms, mossy branches, and dense canopy cover. Thus, these species may be affected negatively by thinning, especially in combination with fire. Bull and Blumton (1999) and Bull and others (2004) found decreases in red squirrel (*Tamiasciurus hudsonicus*) and northern flying squirrel numbers, respectively, one to two years after thinning in coniferous forests in Oregon. Some “arboreal” rodents feed on the ground - for example, truffles are the primary food of northern flying squirrel – and so can be affected by impacts on *and* above the ground, including soil disturbance and compaction, drying effects, canopy thinning, and loss of elevated shelters.

Herbivory

Indirect effects of grazing and browsing on arboreal fauna have not been studied perhaps can be predicted with some accuracy. Whatever effects might occur will be limited to those related to prey abundance and foraging efficiency for species that forage in the ground and shrub layers. Thus, effects on arboreal fauna can be inferred from those on their respective prey species.

5.5.2.6 Bioregion-Specific Effects of Implementing the Program/Alternatives

This section addresses potential indirect and cumulative effects of the Program and Alternatives on wildlife, with emphasis on special-status taxa likely to come up for consideration at the project level.

Some potential exists for substantial adverse effects, but MMR 5 should prevent them. These potential effects and avoidance (mitigation) measures are presented here to guide project managers and consultants. In habitat appropriate for special-status taxa, surveys will be conducted prior to a vegetation treatment project to determine presence or absence. Treatment projects that affect federally or state listed taxa will need to be carried out in accordance with federal or state recovery plans and will require informal consultation with the appropriate agencies to determine if initiation of the formal consultation process is warranted to ensure compliance with currently existing laws.

NORTH COAST/KLAMATH BIOREGION

Vegetation types ("life forms") that will be treated extensively in this bioregion, in terms of either absolute extent or relative extent, are Conifer Forest (by all treatment types) and Conifer Woodland, Hardwood Forest, Hardwood Woodland, Herbaceous, and Shrub (primarily by prescribed fire). Coastal habitats in this bioregion are typically not fire-dependent and for the most part cannot be considered fire-suppressed. Wildlife in these habitats probably will not benefit greatly from treatment and those dependent on cool, moist forest conditions may be harmed by it if it results in warmer, drier ambient conditions. Conversely, inland habitats outside the fog belt have elevated fuel loadings due to fire suppression and are extremely vulnerable to stand replacement wildfire. Thus, treatment effects that reduce wildfire risk in these habitats will be of benefit to their wildlife in the long run despite potential adverse, short-term, direct effects. Forest habitats in this bioregion did not evolve under intense grazing or browsing pressure, so application of livestock for fuel reduction should be carried out judiciously.

The ten special-status taxa meeting our selection criteria in this bioregion fall into two groups. The first group consists of upland species associated with old-growth forests: northern goshawk (*Accipiter gentilis*), marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), Sonoma tree vole, Humboldt marten (*Martes americana humboldtensis*), and fisher. These species all require large tracts of mature, structurally complex forest with abundant "legacy features" (large trees, tree and snag cavities, broken treetops, brooms, logs, brush piles, etc.), though their specific requirements vary. For example, the goshawk prefers a relatively open understory and may benefit from treatments that create this condition; the murrelet requires only a dense canopy of mature, mossy trees, which will not be affected by treatment; and the vole sometimes burrows into leaf litter, which may be removed by fire but supplemented by mechanical and manual treatments. Fisher home ranges are much larger than VTP projects, ameliorating potential negative effects of treatment. All species are vulnerable to disturbance; especially during the breeding season; fire and mechanical treatments are likely to be the most disruptive.

The second group includes species directly associated with streams or other water sources: southern torrent salamander (*Rhyacotriton variegatus*), tailed frog (*Ascaphus truei*), foothill yellow-legged frog (*Rana boylii*), and osprey (*Pandion haliaetus*). The first two require cold, shady streams or seeps and are not likely to benefit from treatment. The yellow-legged frog, on the other hand, is tolerant of warm water temperatures and likes to bask on sunny rocks and stream banks and thus may benefit from treatments that increase penetration of sunlight onto stream courses. Disturbance to springs and seeps may affect these species adversely.

In summary, indirect effects of the VTP in the North Coast/Klamath Bioregion, at least at the project level, are likely to be positive for species in fire-suppressed habitats but may be negative for species of cool, moist, coastal forests. Since no more than 0.26% of any vegetation life form will be treated annually, cumulative effects are expected to be negligible for most species. However, species that are or may be endangered (CNDDB state ranks 1 and 2) may experience moderately adverse cumulative indirect effects.

Table 5.5.2.2
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife In The North Coast/Klamath Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Southern Torrent Salamander	MA	MA	MA	N
Tailed Frog	MA	MA	MA	N
Foothill Yellow-legged Frog	B	B	B	N
Northern Goshawk	B	B	B	B
Marbled Murrelet	N	N	N	N
Osprey	N	N	N	N
Northern Spotted Owl	SA	SA	SA	N
Sonoma Tree Vole	N	B	B	N
Humboldt Marten	N	N	N	N
Fisher	N	N	N	N

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

Fire and/or thinning could cause substantial adverse indirect effects to the federally threatened northern spotted owl if projects occur in areas utilized by this subspecies. The effects on northern spotted owl of widespread fuel reduction are poorly known. Treatments that reduce spatial heterogeneity in vegetation or reduce tree diversity may have harmful effects on the owl's prey base. In inland areas, the spotted owl preys mainly on flying squirrels; prescribed burning and mechanical thinning both have been shown to reduce flying squirrel abundance (Meyer and others 2007). More directly, microclimate changes may reduce stand quality for spotted owls, which prefer cool, moist conditions. Any negative impact to northern spotted owl habitat could be considered a violation of the ESA and a breach of a significance threshold. However, if fuels can be reduced at a scale sufficient to reduce the risk of wildfire across a watershed without substantially reducing canopy cover, the benefit of habitat longevity will outweigh the potential shorter-term negative effects. Habitat quality for northern spotted owls may need to be assessed at the landscape rather than the stand or activity center level.

Moderately Adverse Effects

Fire and/or thinning (mechanical and manual) may have moderately adverse indirect effects to on Southern torrent salamander and tailed frog by removing cover near riparian habitats that moderate stream temperatures and causing sedimentation into streams.

Alternatives

Alternatives 1 and 4 would reduce greatly the magnitude of indirect and cumulative effects in the North Coast/Klamath Bioregion but would not eliminate the existing potential of the VTP for substantial adverse effects on northern spotted owl.

Alternative 3 would not alter effects on northern spotted owl but would reduce moderately adverse negative effects on southern torrent salamander and tailed frog to negligible.

MODOC BIOREGION

Very few projects will occur in this bioregion, with no more than 0.23% of any vegetation type treated annually, so landscape-level impacts, whether positive or negative, will be minimal. Vegetation types ("life forms") that will be treated extensively in this bioregion are Conifer Forest, Hardwood Forest, Hardwood Woodland, and Herbaceous, with prescribed fire and herbivory being the primary treatment types. These habitats have evolved with both fire and grazing pressure, so treatment can be expected to simulate natural processes and reverse effects of fire suppression, benefiting most wildlife species at the project level. However, over-grazing is already a major environmental problem in this bioregion, contributing to tree encroachment of herbaceous and shrub habitats.

Four of the five special-status species selected for analysis in this bioregion are raptors. The northern goshawk and spotted owl are species of mature forests. The goshawk requires large trees for nesting and prefers open understory for hunting and detection of nest predators. It does not depend directly on any habitat elements that will be removed by treatment and prefers conditions that will result from treatment, and its prey species are not likely to be affected negatively by burning or herbivory. Thus, it stands to benefit from the VTP. The owl prefers dense, cool conifer stands, and these conditions should not be affected by prescribed fire or herbivory; however, its primary prey species, the northern flying squirrel, depends on truffles, which decline in abundance following either prescribed fire or mechanical thinning. The osprey and bald eagle (*Haliaeetus leucocephalus*) both require clear, open bodies of water for hunting and typically nest nearby, the osprey in large snags, dead-topped trees, or cliffs and the eagle usually in large, live trees. The rot that creates such structure is a natural ecosystem process that contributes snag development and large woody debris that provide structure and complexity to forests and rangelands. VTP treatments will not destroy nest sites, and MMRs should prevent erosion and siltation, which could decrease water clarity.

The fifth species, the badger (*Taxidea taxus*), inhabits open habitats with dry, friable soils, conditions that should be enhanced by the VTP. Prescribed burning in particular should result in increased numbers of most badger prey species. The only potential negative effect of the VTP on badger is use of livestock in areas already over-grazed, reducing forage available for prey species, but it is not expected that herbivory will be used, or indeed necessary, in such situations.

In summary, effects on Modoc's wildlife from the VTP are expected to be negligible at the bioregion-level. Reintroduction of fire to Modoc in the ecosystems discussed above should be beneficial to most wildlife.

Table 5.5.2.3 **Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the Modoc Bioregion**				
	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Osprey	N	N	N	N
Bald Eagle	N	N	N	N
Northern Goshawk	N	N	N	N
Spotted Owl	N	N	N	N
American Badger	N	N	N	N

N = Negligible or Neutral. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Alternatives

None of the alternatives would introduce negative effects on wildlife in the Modoc Bioregion not present in the Program.

SACRAMENTO VALLEY BIOREGION

Wildlife remaining in this highly developed bioregion is already heavily affected by human activities and most taxa are fairly disturbance tolerant. Upland habitats here are fire and grazing-adapted and wildlife should, on the whole, benefit from treatment. The understory of the remaining riparian habitat in the bioregion is choked with invasive plants and should benefit from efforts to control them. Vegetation types (“life forms”) that will be treated extensively in this bioregion are Hardwood Forest, Hardwood Woodland, Herbaceous, and Shrub; all treatment types will be used throughout. These vegetation types occur mostly in higher elevations around the perimeter of the bioregion, particularly in the north, and are essentially the only treatable vegetation types occurring in the bioregion. Compared to the other bioregions, treatment will be applied to very large proportions of these habitats, ranging from 1% to 12% annually (e.g., hardwood forest, see botanical analysis); thus, effects on wildlife could be quite substantial.

Of the 12 special-status taxa selected for analysis in this bioregion, few have any real potential for negative indirect effects of treatment. One, the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), is a specialist on blue elderberry (*Sambucus mexicana*), preferring to lay its eggs in stressed plants no more than eight inches in diameter. Cutting, burning, grazing, and herbicide use have been identified as causes of elderberry mortality and the subsequent decline of the beetle. Thus, treatments in potential beetle habitat must be implemented so as to avoid impacts to elderberries; this may be difficult with anything other than manual treatment.

Species such as California tiger salamander (*Ambystoma californiense*), western spadefoot (*Spea hammondii*), Western pond turtle (*Emys marmorata*), white-tailed kite (*Elanus leucurus*), Swainson’s hawk (*Buteo swainsoni*), and burrowing owl (*Athene cunicularia*) that utilize grassland habitats generally are expected to benefit indirectly from treatment, which will help maintain grasslands by preventing encroachment of woody vegetation. However, tilling can destroy the burrows on which some of these species rely. The silver-haired bat (*Lasionycteris noctivagans*) forages over open, brushy areas and may benefit from treatment of shrub habitats. The other selected species utilize habitat elements that will not be affected by the Program.

In summary, VTP treatment in the Sacramento Valley Bioregion will be quite extensive. Grassland and savanna wildlife is likely to benefit indirectly from treatment. Conversely, understory species of riparian habitats may be harmed unless their specific habitat elements can be avoided.

Table 5.5.2.4
Potential Indirect Effects Of The VTP at the Bioregion Level on Selected Special-Status Wildlife in the Sacramento Valley Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Valley Elderberry Longhorn Beetle	SA	SA	N	SA
California Tiger Salamander	SA	SA	B	B
Western Spadefoot	B	MA	B	B
Western Pond Turtle	B	B	B	B
Great Blue Heron	N	N	N	N
Osprey	N	N	N	N
White-tailed Kite	B	B	B	B
Bald Eagle	N	N	N	N
Swainson’s Hawk	B	B	B	B
Western Yellow-billed Cuckoo	N	N	N	N
Burrowing Owl	B	MA	B	B
Silver-haired Bat	B	B	B	B

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

The federally threatened valley elderberry longhorn beetle is a riparian specialist dependent on a certain size class of a particular plant species (blue elderberry) for breeding. Any loss of this plant due to treatment could be considered a violation of the ESA and a breach of the determination threshold. However, treatments that remove exotic vegetation but spare elderberry may enhance growth of elderberry seedlings and benefit the beetle.

The federally threatened California tiger salamander spends most of the year in rodent burrows and requires surface cover (boards, logs, rocks, etc.) during its annual migrations to and from breeding sites. Treatments that destroy burrows (mechanical) or surface cover (fire) in the salamander’s habitat could be considered violations of the ESA and breaches of the determination threshold but will be avoided with the implementation of MMR 5. However, treatments that maintain grasslands without removing these habitat elements will benefit this species.

Moderately Adverse Effects

Mechanical treatments may have moderately adverse indirect effects on Western spadefoot as a result of direct mortality due to crushing by machinery and on burrowing owl as a result of collapse of burrows used for nesting.

Alternatives

Alternative 1 would reduce greatly the magnitude of indirect and cumulative effects in the Sacramento Valley Bioregion but would not eliminate the existing potential of the VTP for substantial adverse effects on valley elderberry longhorn beetle or California tiger salamander.

Alternative 3 would reduce to some extent, but would not eliminate, the magnitude of substantial adverse effects on valley elderberry longhorn beetle. It would not alter substantial adverse effects on California tiger salamander.

Alternative 4 would reduce the effects of prescribed fire to negligible for all species. It would reduce other effects as well but would not eliminate the potential for substantial adverse effects from mechanical treatments on valley elderberry longhorn beetle or California tiger salamander or of herbivory on valley elderberry longhorn beetle.

SIERRA BIOREGION

With increasing frequency, the Sierra Bioregion is experiencing catastrophic wildfires which are a result of increased fuels due to fire suppression. Treatments that reintroduce fire (or its effects) to fire-dependent ecosystems, such as most low-to-mid-elevation Sierra habitats are, expected to benefit the region’s wildlife. High-elevation habitats, which are less fire-dependent, are mostly outside CAL FIRE’s jurisdiction and excluded from the Program with the exception of private timberland owners and communities in the upper elevational range that have received grant funding for treatment from CAL FIRE. Vegetation types (“life forms”) that will be treated extensively in this bioregion are Conifer Forest (all treatment types), Hardwood Forest and Hardwood Woodland (primarily by fire and mechanical methods), Herbaceous (all treatment types except herbicides), and Shrub (largely by fire). Over the past 150 years, intensive forest management, fire suppression, grazing, and water diversions have degraded much of the habitat value of these vegetation types. Although there will be many VTP projects in this bioregion, the vegetation types to be treated are extensive and no more than 0.66% of any one type will be treated annually.

Of the 16 special-status taxa selected for analysis in this bioregion, only three are likely to experience substantial adverse indirect effects from fuel reduction treatments. The California spotted owl (*Strix occidentalis occidentalis*) requires dense, cool conifer stands and may suffer from understory thinning as well as reduction of its primary prey, the northern flying squirrel (*Glaucomys sabrinus*), as a result of truffle depletion. Similarly, great gray owl may be adversely impacted by thinning that would reduce canopy closure and thus cover for juveniles and leaning trees and other structures used for perching. Herbivory may also have an adverse impact on great gray owls by reducing their preferred prey species. The northern goshawk prefers mature stands with an open understory and likely will benefit from fuel reduction. The other forest species utilize habitats or habitat elements that will not be affected by treatment.

Several special-status species inhabit grasslands on the southwestern edge of the bioregion. This early-successional habitat is adapted to frequent fires and regenerates quickly. Prescribed fire will help maintain grasslands and is expected to benefit these species, several of which also use adjacent aquatic habitats that will not be treated. Tilling and mowing, however, may destroy burrows and burning may destroy cover objects, negatively affecting California tiger salamander. The two bats on the list utilize a wide variety of habitats but generally forage in open areas and thus should benefit from treatment.

In summary, VTP treatment in the Sierra Bioregion generally will help reverse the effects of fuel buildup due to fire suppression. Effects on wildlife will be negligible or positive overall, with only a few causes for concern.

Table 5.5.2.5
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the Sierra Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
California Tiger Salamander	SA	SA	N	B
Foothill Yellow-legged Frog	B	B	B	B
Mountain Yellow-legged Frog	N	N	N	N
California Red-legged Frog	SA	SA	N	N
Western Pond Turtle	B	B	N	B
Northern Goshawk	B	B	B	B
California Spotted Owl	MA	MA	MA	N
Great Gray Owl	SA	SA	SA	SA
Willow Flycatcher	N	N	N	N
Pallid Bat	B	B	B	B
Western Mastiff Bat	B	B	N	B
San Joaquin Kit Fox	B	SA	N	B
American Marten	N	N	N	N
Fisher	MA	MA	MA	N
Wolverine	N	N	N	N
American Badger	B	MA	N	B

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

See the Sacramento Valley Bioregion section for a discussion of substantial adverse effects on the California tiger salamander.

The state endangered great gray owl may be adversely impacted by thinning that would reduce canopy closure that provides cover for juveniles and leaning trees and other structures used for perching. Herbivory may also have an adverse impact on great gray owls by reducing their preferred prey species.

The federally threatened California red-legged frog requires dense vegetation and deep leaf litter in riparian zones. Fuel reduction treatments in these areas are likely to disrupt and/or diminish these critical habitat elements, constituting a violation of the ESA and a breach of the determination threshold.

The federally endangered San Joaquin kit fox (*Vulpes macrotis mutica*) is a burrowing species, creating underground dens for shelter and breeding. Mechanical treatments in grassland habitats may destroy active fox burrows and dens. Such impacts to fox habitat could be considered violations of the ESA and thus breaches of the determination threshold. However, other treatments that maintain grasslands without damaging burrows will benefit this species.

Moderately Adverse Effects

The California spotted owl (*Strix occidentalis occidentalis*) requires dense, cool conifer stands and may suffer from understory thinning as well as reduction of its primary prey, the northern flying squirrel (*Glaucomys sabrinus*), as a result of truffle depletion.

Treatments that may substantial reduce overhead cover or consume or remove understory debris may have a negative impact of fisher.

American badger is also a burrowing species and susceptible to burrow collapse by machinery while applying mechanical treatments.

Alternatives

Alternative 1 would reduce greatly the magnitude of indirect and cumulative effects in the Sierra Bioregion but would not eliminate the existing potential of the VTP for substantial adverse effects from prescribed fire or mechanical treatments on California tiger salamander or San Joaquin kit fox.

Alternative 3 would not alter substantial adverse effects on California tiger salamander or San Joaquin kit fox.

Alternative 4 would reduce greatly the effects of prescribed fire on all species and would reduce other effects as well but would not eliminate the potential for substantial adverse effects on California tiger salamander or San Joaquin kit fox.

BAY AREA/DELTA BIOREGION

Most habitats in this bioregion are severely fragmented by development. Vegetation types ("life forms") that will be treated extensively in this bioregion are Conifer Forest (primarily by prescribed fire and mechanical treatment) and Hardwood Forest, Hardwood Woodland, Herbaceous, and Shrub (primarily by prescribed fire). Most of these habitats, including annual grasslands, chaparral, oak woodlands, and even redwood forests, evolved with fire and are well adapted to it and, in many cases, suffering from its absence. Fuel reduction in these habitats can be expected to have beneficial indirect effects on wildlife. No more than 0.6% of any vegetation type will be treated annually.

Three of the six special-status taxa that met the selection criteria for analysis in this bioregion should benefit from fuel reduction treatments because they require early-successional habitats. The Zayante band-winged grasshopper (*Trimerotropis infantilis*) often occurs in grassy areas in sparse chaparral and likely will benefit from treatments that prevent dense shrub cover from developing.

The western pond turtle is expected to benefit because treatment will keep potential nest sites from being shaded out by woody vegetation. The San Joaquin kit fox inhabits open grassland with dense rodent populations, an environment well adapted to periodic fires.

The three remaining species may not benefit from VTP treatments. The monarch butterfly (*Danaus plexippus*) forms winter roosts of many thousands of individuals in sheltered groves of several exotic tree species (eucalyptus, Monterey pine, and Monterey cypress). Although some known monarch butterfly groves are protected, others could be targeted for removal under the VTP and loss of these groves could have a locally devastating impact on this species. However, MMR 5 likely will be sufficient to prevent impacts to these habitats, and the species is still numerous enough that cumulative effects are unlikely. The California tiger salamander depends on logs and other cover objects during migration, and these could be destroyed by fire. The California red-legged frog (*Rana draytonii*) requires well-vegetated riparian zones with thick leaf litter and may be harmed by treatments that disrupt the ground layer.

In summary, indirect effects of the VTP in the Bay Area/Delta Bioregion, at least at the project level, are likely to be positive for grassland, chaparral, oak woodland, and redwood forest species but not for those of coastal riparian zones or other non-fire-adapted habitats.

Table 5.5.2.6
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the Bay Area/Delta Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Zayante Band-winged Grasshopper	B	N	N	N
monarch butterfly	MA	MA	N	N
California Tiger Salamander	SA	N	N	N
California Red-legged Frog	SA	SA	N	N
Western Pond Turtle	B	N	N	N
San Joaquin Kit Fox	B	N	N	N

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

The federally threatened California tiger salamander requires surface cover (boards, logs, rocks, etc.) during its annual migrations to and from breeding sites. Prescribed fire may destroy surface cover in the salamander's habitat, which could be considered a violation of the ESA and a breach of the determination threshold. However, treatments that maintain grasslands without removing these habitat elements will benefit this species.

See the Sierra Bioregion section for a discussion of substantial adverse effects on the California red-legged frog.

Moderately Adverse Effects

Monarch butterflies are likely to suffer adverse impacts to local populations where treatments may occur in groves housing large winter roosts.

Alternatives

Alternative 1 would reduce all effects greatly and would reduce substantial adverse effects of mechanical treatment to negligible but would not eliminate the existing potential of the VTP for substantial adverse effects on California red-legged frog from prescribed fire.

Alternative 3 would reduce the potential for substantial adverse effects on California red-legged frog to negligible. It would not eliminate the potential for substantial adverse effects from prescribed fire on California tiger salamander.

Alternative 4 would reduce potential effects of prescribed fire to negligible. It would reduce but not eliminate the potential for substantial adverse effects from mechanical treatments on California red-legged frog.

SAN JOAQUIN VALLEY BIOREGION

The vegetation types (“life forms”) that will be treated extensively in this bioregion are Conifer Forest and Desert Shrub (no single treatment type will treat more than 0.1% of the bioregion); Conifer Woodland (prescribed fire); Hardwood Forest, Herbaceous, and Shrub (fire and mechanical); and Hardwood Woodland (all treatment types). These habitats exist today primarily in the northeast and southwest portions of the bioregion (lower Sierra Nevada foothills and inner Coast and Transverse Ranges, respectively); the valley floor largely has been converted to agriculture. Fire is a natural part of these ecosystems and prescribed fire is expected to have beneficial indirect effects on wildlife. Few projects will occur here; at most, 1.4% of any one vegetation type will be treated annually.

The five special-status taxa selected for analysis in this bioregion are all species of grassland and open scrub and persist mainly in areas that have escaped complete agricultural conversion: hilly areas such as the Elk and Panoche hills and disjunct plains and valleys such as the Carrizo and Elkhorn plains and the Cuyama Valley. All are burrow-dwelling species and should benefit from prescribed fire applied at seasonally appropriate times, particularly early in the rainy season, when new growth will be facilitated. Mechanical treatments, on the other hand, have the potential to compact the soil and destroy burrows and should not be used in areas where burrowing species occur.

In summary, VTP treatment in the San Joaquin Valley Bioregion will not be very extensive, and prescribed fire, applied appropriately, is expected to be beneficial to most wildlife. Mechanical treatments should be avoided in areas occupied by sensitive, fossorial species, which comprise the primary special-status taxa in the bioregion.

Table 5.5.2.7
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the San Joaquin Valley Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Blunt-nosed Leopard Lizard	B	SA	N	N
Nelson's Antelope Squirrel	B	SA	N	N
San Joaquin Pocket Mouse	B	MA	N	N
Giant Kangaroo Rat	B	SA	N	N
San Joaquin Kit Fox	B	SA	N	N

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

Agriculture, urbanization, petroleum, mineral, and other developments have destroyed over 95% of the San Joaquin Valley wildlands. All five of the special-status taxa selected for this analysis have had their populations drastically reduced due to human development and indiscriminate poisoning. Consequently, all but the San Joaquin pocket mouse are federally or state listed as threatened or endangered and so any negative effects on these species would be considered significant. All five of these selected taxa utilize burrows for shelter. Vehicles or heavy livestock may crush burrows or compact the soil making areas uninhabitable. Furthermore, many of these species require a particular proportion of vegetative cover mixed with open space. Removing too much or too little cover may increase the likelihood of a species being preyed upon, or reduce the availability of a critical food source.

Moderately Adverse Effects

See the section about Substantial Adverse Effects (above) as it includes a discussion of San Joaquin pocket mouse.

Alternatives

Alternatives 1 and 4 would reduce nearly all effects due to the VTP to negligible since so little of the landscape would be treated. However, in many grasslands or hardwood savannas where fire has been suppressed, grassland wildlife will continue to lose habitat where shrubs and trees encroach.

Alternatives 2 and 3 would slightly increase the number of acres treated by fire, mechanical, and manual methods, but these increases are not substantial enough to cause effects to wildlife to differ from the proposed program. Herbicides – often used for maintaining previously treated areas and removing invasive exotic vegetation – would be reduced by these alternatives. Exotic plants are a major problem in the San Joaquin Valley where they may outcompete native vegetation after disturbances. Wildlife may suffer permanent habitat loss if exotics take over following vegetation treatments.

CENTRAL COAST BIOREGION

This bioregion contains very diverse habitats ranging from coastal dunes and maritime chaparral to conifer forests and alkali scrub. Wildlife species that may be affected by the VTP in this bioregion are similarly diverse. Coastal habitats have been affected severely by development. Catastrophic fire is a major concern in chaparral and forest habitats. Agriculture and overgrazing have damaged interior hill and valley ecosystems. Vegetation types ("life forms") that will be treated extensively in this bioregion are Conifer Forest and Hardwood Forest (prescribed fire); Desert Shrub, Desert Woodland, and Shrub (fire and mechanical treatments); Hardwood Woodland (fire, mechanical, manual, and herbicides); and Herbaceous (all treatment types). No more than 0.7% of any one vegetation type will be treated annually.

The 15 special-status taxa selected for analysis in this bioregion occur primarily in interior valley grassland and scrub, coastal shrub, and palustrine or lacustrine habitats. The interior species are mostly expected to benefit from seasonally appropriate burning but could be harmed by mechanical treatments that destroy burrows and compact soil. These species include the California tiger salamander, blunt-nosed leopard lizard (*Gambelia sila*), burrowing owl, Nelson's antelope squirrel (*Ammospermophilus nelsoni*), giant kangaroo rat (*Dipodomys ingens*), Tulare grasshopper mouse (*Onychomys torridus tularensis*), San Joaquin kit fox, and badger.

The coastal species are typically dependent on specific plants or other habitat elements that may be retained effectively only by manual treatment. Destruction of unprotected roost groves would have locally devastating impacts on the monarch butterfly. Smith's blue (*Euphilotes enoptes smithi*) would benefit from treatments that enhance growth of its host plant, buckwheat, but clearing of vegetation for firebreaks has been cited as a threat. The black legless lizard (*Anniella pulchra nigra*) burrows in leaf litter and sandy soil under lupines and mock heather, which could be destroyed by fire, livestock, or heavy equipment. Conversely, legless lizards would benefit from the removal of invasive exotic plants such as ice plant (*Carpobrotus edulis*) and European beachgrass (*Ammophila arenaria*) and the restoration of native plant communities.

Some of the water-associated species prefer dense cover that might be removed or degraded by treatment. The California red-legged frog needs dense, moist ground cover that may be removed by most treatment types. Cooper's hawk (*Accipiter cooperii*) nests in dense riparian groves; understory thinning may make conditions unsuitable for it.

In summary, VTP treatment in the Central Coast Bioregion will have mixed effects on wildlife, with the bulk of potential adverse effects resulting from mechanical treatments that remove or destroy specific essential habitat elements. Reintroduction of fire into fire-suppressed habitats will be mostly beneficial.

Table 5.5.2.8
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the Central Coast Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Monarch	MA	MA	MA	N
Smith's Blue	SA	SA	N	SA
California Tiger Salamander	SA	SA	N	N
California Red-legged Frog	SA	SA	N	SA
Western Pond Turtle	B	B	B	B
Blunt-nosed Leopard Lizard	B	SA	N	N
Black Legless Lizard	SA	SA	N	N
Cooper's Hawk	N	MA	MA	N
Prairie Falcon	N	N	N	N
Burrowing Owl	B	MA	B	B
Nelson's Antelope Squirrel	B	SA	N	N
Giant Kangaroo Rat	B	SA	N	N
Tulare Grasshopper Mouse	B	SA	N	N
San Joaquin Kit Fox	B	SA	B	B
Badger	B	MA	B	B

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

See the Bay Area/Delta Bioregion section for a discussion of substantial adverse effects on the California tiger salamander and the California red-legged frog.

See the San Joaquin Valley Bioregion section for a discussion of substantial adverse effects on the blunt-nosed leopard lizard, Nelson's Antelope Squirrel, giant kangaroo rat, and San Joaquin kit fox. This discussion also applies to the Tulare grasshopper mouse which also inhabits burrows primarily in the San Joaquin Valley.

The federally endangered Smith's blue inhabits coastal sand dunes and coastal chaparral where their entire lives are spent in association with two species of buckwheat, *Eriogonum parvifolium* and E. *latifolium*. Habitat destruction and degradation have been caused by human development and invasive exotic plants. Treatments that kill large quantities of its host plant would have devastating effects on its population.

The black legless lizard – actually a melanistic form of the California legless lizard – inhabits shrubby areas with sandy soil where it can easily burrow. It occurs primarily along the coast where its habitat has been destroyed by human development and invasive exotic plants. Treatments that remove native shrub cover or leaf litter where it occurs will have adverse effects on this lizard. Although this taxon is not officially listed, the CNDDB considers them to be endangered and further destruction of their habitat may cause them to drop from S2 to S1 status.

Moderately Adverse Effects

See the Bay/Delta Bioregion section for a discussion of moderately adverse impacts to monarch butterfly.

Cooper's hawk (*Accipiter cooperii*) nests in dense riparian groves. Moderately adverse impacts may result from understory thinning which may alter this habitat type such that it becomes unsuitable for Cooper's hawk.

See the Sacramento Valley Bioregion section for a discussion of moderately adverse impact to burrowing owl.

See the Sierra Bioregion section for a discussion of moderately adverse impacts on American Badger.

Alternatives

Alternative 1 would reduce most effects to negligible since so little of the landscape would be treated. However, considering the increased likelihood of catastrophic wildfire, wildlife may end up faring worse than their current situation when their habitat is completely destroyed.

Alternative 2 would slightly increase the number of acres treated by fire, mechanical, and manual methods, but these increases are not substantial enough to cause effects to wildlife to differ from the proposed program. Herbicides – often used for maintaining previously treated areas and removing invasive exotic vegetation – would be reduced by these alternatives. Exotic plants are a major problem on the Central Coast where they often outcompete native vegetation after disturbances. Wildlife may suffer permanent habitat loss if exotics take over following vegetation treatments.

Alternative 3 would reduce the potential for substantial adverse effects on California red-legged frog to negligible. It would not eliminate the potential for substantial adverse effects from prescribed fire on California tiger salamander.

Alternative 4 would reduce effects due to prescribed fire to negligible since so little of the landscape would be treated with fire. Effects due to mechanical treatments would be greatly reduced, but could still cause problems for burrow-dwelling wildlife.

MOJAVE BIOREGION

Only a handful of VTP projects will occur in this bioregion. No vegetation type ("life form") will be treated at more than 1,000 acres/year; however, at least 0.1%/year of four types will be treated annually: Hardwood Forest (primarily by prescribed fire and mechanical) and Conifer Forest, Hardwood Woodland, and Herbaceous (primarily by prescribed fire). Hardwood Forest and Hardwood Woodland in this bioregion are likely composed of cottonwood and oak. At lower elevations, these life forms may benefit from treatment where riparian areas or oak forest understories are choked by shrubs. At higher elevations, though, the fire-return intervals are longer (>30 years), which means that frequent treatments (<20 years) could reduce habitat quality for wildlife. Conifer Forest in the bioregion is composed of a mix of species that may benefit from treatments at lower elevations, but not at higher elevations. The Herbaceous life form is composed of arid grasslands that have a short fire-return interval, so treatments may provide a benefit by removing encroaching shrubs.

Four of the five special-status taxa selected for analysis in this bioregion occur in arid desert shrub and one occurs in conifer woodland. These life forms will not be treated extensively, and at a bioregion level all indirect effects should be negligible. Although desert bighorn sheep (*Ovis canadensis nelsoni*) typically inhabit rocky, barren areas – a habitat excluded from the VTP – males do select areas with vegetative cover in order to put on weight and obtain nutrients for growing their horns for the rut. However, considering how little vegetation will actually be treated and the large home range size of big horn sheep, indirect effects to this species will be negligible. The prairie falcon (*Falco mexicanus*) nests on cliffs, which will not be affected by treatments, and the few treatments conducted on its hunting grounds will not be extensive enough to have a significant effect on its food supply. The Mohave ground squirrel (*Spermophilus mohavensis*) resides in open desert shrub communities where they can dig burrows in friable soil. This species may benefit from treatments that reduce dense expansive shrublands and create a mosaic of shrubs and open area. In areas where the distribution of desert shrubs is already amenable to Mojave ground squirrels, treatments further reducing cover are likely to make this habitat unsuitable for them. American badger occurs in open desert shrub and herbaceous habitats where they hunt ground squirrels and other fossorial prey. Treatments in either habitat will have negligible effects on this species. The gray vireo (*Vireo vicinior*) occurs in the mountains of the Mojave Desert in open juniper woodland that is often mixed with sagebrush. This is another habitat that has a long fire-return interval and treatments in it are likely to have deleterious effects on gray vireo individuals; however, these effects will not be extensive enough to cause its population to decline within the bioregion.

In summary, indirect effects of the VTP in the Mojave Bioregion are unlikely to benefit species that occur in desert habitats that have long fire-return intervals. However, considering how few treatments this bioregion will receive, program-level effects to these species should be negligible.

Table 5.5.2.9
Potential Indirect Effects at the Bioregion Level of the VTP on Selected Special-Status Wildlife in the South Coast Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Prairie Falcon	N	N	N	N
Gray Vireo	N	N	N	N
American Badger	N	N	N	N
Desert Bighorn Sheep	N	N	N	N
Mojave Ground Squirrel	N	N	N	N

N = Negligible or Neutral. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items

Alternatives

None of the alternatives are expected to have more than negligible effects on wildlife in this bioregion.

SOUTH COAST BIOREGION

Vegetation types ("life forms") that will be treated extensively in this bioregion are Shrub (by all treatment types), Hardwood Woodland (primarily by prescribed fire and mechanical treatments), Herbaceous, and Desert Shrub (primarily by prescribed fire). Shrub environments in the South Coast typically have a fire-return interval of 20-80 years. These fires generally are large and consume much of the aboveground vegetation. Hardwood Woodland and Herbaceous environments have a similar fire regime except that the fireline tends to burn with less intensity and severity. Fires in these habitats generally burn through the understory, removing shrubs and encroaching conifers to leave a hardwood/savannah mosaic. Desert shrub has a longer fire-return interval than the other vegetation types.

Four of the seven special-status taxa selected for discussion in this bioregion occur in the Shrub life form. Overall, responses to treatments that reduce shrub cover will vary depending on species. The California gnatcatcher (*Polioptila californica californica*) and Southern California rufous-crowned Sparrow (*Aimophila ruficeps canescens*) are permanent residents of semi-open sage scrub habitats. These birds avoid dense, overgrown shrublands and so may benefit from treatments that create a better-proportioned mosaic of shrub mixed with open areas. Rufous-crowned sparrow populations increase in areas that have been recently disturbed by either fire or light grazing. However, gnatcatcher populations are likely to decline if shrub removal treatments result in a conversion of sage scrub to exotic grassland. The San Diego horned lizard (*Phrynosoma coronatum* (*blainvillii* pop.)) also requires a mosaic of shrubs mixed with open areas and may also benefit when dense shrublands are treated. However, native harvester ants, which are the main food item of horned lizards, are often displaced by exotic Argentine ants (*Iridomyrmex humilis*) when shrublands are fragmented by treatments in the WUI. Since horned lizards do not eat Argentine ants, horned lizard populations are likely to decline if treated shrublands allow Argentine ants to invade. The Belding's orange-throated whiptail (*Aspidoscelis hyperythra beldingi*) occurs in semi-arid brushy areas but avoids open areas and habitats modified by humans. The populations of these lizards are likely to decline if their habitats are treated and may be further threatened if their primary food item, a single species of subterranean termite (*Reticulitermes hesperus*), is displaced by Argentine ants.

The San Diego cactus wren (*Campylorhynchus brunneicapillus sandiegensis*) and the San Diego desert woodrat (*Neotoma lepida intermedia*) also occur in coastal sage scrub; however, a principal habitat element for both species is the presence of cactus. Since cacti require a long time to grow to a height sufficient to offer protection from predators and provide nesting structures, treatments in areas with cacti are likely to adversely affect populations of these two species. Furthermore, woodrat middens, which can be used by generations of woodrats, would likely be consumed by prescribed fire.

Stephens' kangaroo rat (*Dipodomys stephensi*) prefers areas of open grassland with a high proportion of prostrate forbs and abundant bare areas where it can burrow. Prescribed fire is an effective tool for improving this species' habitat and for increasing its population. Light grazing may also be beneficial. Mechanical treatments that disturb the soil and may damage burrows are likely to have adverse direct effects on this species.

In summary, indirect effects of the VTP in the South Coast Bioregion are likely to be positive for species that occur in open habitats where exotic pest species are unlikely to invade. Since no more than 0.28% of any life form will be treated annually, bioregion-level effects are expected to be relatively minimal.

Table 5.5.2.10
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the South Coast Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
San Diego Horned Lizard	N	N	N	N
Belding's Orange-throated Whiptail	SA	SA	SA	SA
San Diego Cactus Wren	SA	SA	SA	SA
California Gnatcatcher	N	N	N	N
Rufous-crowned Sparrow	B	B	B	B
Stephens' Kangaroo Rat	B	N	N	B
San Diego Desert Woodrat	MA	MA	MA	MA

SA = Substantial Adverse, MA = Moderately Adverse, N = Negligible or Neutral, B = Beneficial. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Substantial Adverse Effects

Belding's orange-throated whiptail habitat has been reduced by as much as 75% by human development. This subspecies occurs in semi-open chaparral and coastal sage scrub environments, but avoids areas where all shrub cover has been removed. The presence of this lizard is often associated with alluvial fan scrub and streamside terraces where they can find sandy soil for digging. The termites that these lizards chiefly prey upon require some woody vegetation as their food base. Fuel reduction treatments that completely remove woody vegetation such as prescribed fire and mechanical treatments will be detrimental to this lizard. Although this taxon is not officially listed, the CNDDB considers them to be endangered and further destruction of their habitat may cause them to drop from S2 to S1 status.

San Diego cactus wrens inhabit coastal sage scrub where prickly pear (*Opuntia littoralis* and *O. oricola*) or coastal cholla (*O. prolifera*) is the dominant component. Human development has reduced this coastal sage scrub habitat by as much as 90%, and in 1990, only 400 pairs of these wrens were estimated to still exist (Rea and Weaver 1990). These wrens require cactus cover of 25% to 65% of at least one meter in height in order to nest. Fire is the primary factor limiting cactus coverage in Southern California. Since it takes a long time for these cacti to grow to the necessary height, cactus wrens are slow to recolonize areas after a disturbance such as fire (Bontrager and others 1995). Although this taxon is not officially listed, the CNDDB considers their status to be rare to endangered and further destruction of their habitat may cause their status to drop from S3S2 to S2.

Moderately Adverse Effects

As discussed at the beginning of this section, San Diego desert woodrat occupies coastal sage scrub and an essential habitat element for the species is the presence of cacti which they use for protection from predators and nest structures. Due to the length of time it takes for cacti to develop sufficient height to provide such structure, treatments that would remove cacti are likely to have an adverse impact.

Further, woodrat middens which are also important habitat elements for the species that can be used by generations of woodrats are likely to be destroyed.

Alternatives

Alternative 1 would reduce nearly all effects to negligible since so little of the landscape would be treated. However, considering the increased likelihood of catastrophic wildfire, wildlife may end up faring worse than their current situation when their habitat is completely destroyed.

Alternatives 2 and 3 would slightly increase the number of acres treated by fire, mechanical, and manual methods, but these increases are not substantial enough to cause effects to wildlife to differ from the proposed program. Herbicides – often used for maintaining previously treated areas and removing invasive exotic vegetation – would be reduced by these alternatives. Exotic plants are a major problem on the South Coast where they often outcompete native vegetation after disturbances. Wildlife may suffer permanent habitat loss if exotics take over following vegetation treatments.

Alternative 4 would drastically reduce the number of acres treated by fire, mechanical, and herbicide, and double the number of manual acres treated. This alternative would cause fewer direct impacts to wildlife than the proposed program, but would increase the likelihood of catastrophic wildfire.

COLORADO DESERT BIOREGION

Vegetation types ("life forms") that will be treated extensively in this bioregion are Desert Shrub and Shrub. The natural fire-return interval for desert shrub environments is extremely long, so vegetation treatments would likely reduce habitat suitability for species that occupy this vegetation type. However, since there are nearly five million acres of desert shrub in this bioregion, the 0.05% treated annually should not result in significant cumulative effects. On the other hand, Conifer Forest, Conifer Woodland, Desert Woodland, Hardwood Forest, Hardwood Woodland, and Shrub vegetation types will be treated extensively in terms of relative extent. Since Conifer Forest, Hardwood Forest, and Hardwood Woodland are limited in extent in the bioregion (< 10,000 acres), avoidance of cumulative effects on special-status taxa occurring within them is of particular importance. All of these vegetation types will be treated predominantly with prescribed fire; mechanical and manual treatments and herbicides also will be used widely in Conifer Forest, Hardwood Woodland, and Shrub as will mechanical treatments in Hardwood Forest.

Four of the five special-status taxa selected for analysis in this bioregion occur in arid desert shrub and thus, could be adversely impacted by vegetation treatments. Desert bighorn sheep typically inhabit rocky, barren areas, a habitat excluded from the VTP; however, since males use areas with more vegetative cover than females in order to put on weight and obtain nutrients for growing their horns for the rut, males would likely be adversely affected by treatments designed to remove this critical shrub cover. Females, on the other hand, prefer more-open habitats where they may easily spot potential predators and would likely benefit from a reduction in shrub cover. Although herbivory will not affect this bioregion extensively, domestic livestock have the potential to transmit disease to bighorn sheep, which could spread well beyond the project boundary. The pallid San Diego pocket mouse (*Chaetodipus fallax pallidus*) and red diamond rattlesnake (*Crotalus ruber ruber*) inhabit arid, rocky shrublands and their populations are likely to decline in areas where their habitat is treated. The prairie falcon nests on cliffs, which will not be affected by treatments, but treating desert shrublands may cause populations of ground squirrels – the falcon's primary prey item – to fluctuate.

Yellow-breasted chat (*Icteria virens*) breeds in dense, shrubby riparia and will be adversely affected by treatments where its preferred habitat currently exists. However, tamarisk is a persistent problem in the Colorado Desert where it takes over wetlands that may otherwise be used by chats. Treatments designed to reduce tamarisk may benefit chats by creating more riparian thickets.

In summary, indirect effects of the VTP in the Colorado Desert Bioregion are likely to be negative for wildlife living in desert shrub and other arid shrub environments where the fire return-interval is long. Treatments in healthy riparia will be detrimental to most wildlife currently residing there, whereas removal of exotic vegetation from wetlands will probably enhance habitat suitability for riparian obligates.

Table 5.5.2.11
Potential Indirect Effects of the VTP at the Bioregion Level on Selected Special-Status Wildlife in the Colorado Desert Bioregion

	Prescribed fire	Mechanical treatment	Manual treatment	Herbivory
Red Diamond Rattlesnake	MA	N	N	N
Prairie Falcon	N	N	N	N
Yellow-breasted Chat	N	N	N	N
Desert Bighorn Sheep	N	N	N	MA
Pallid San Diego Pocket Mouse	MA	N	N	N

MA = Moderately Adverse, N = Negligible or Neutral. Adverse effects can be reduced to negligible with adherence to MMRs and checklist items.

Moderately Adverse Effects

As described above, due to their preference for arid, rocky shrublands, red diamond rattlesnake and pallid San Diego pocket mouse are like to be adversely affected by prescribed fire that would consume this critical habitat.

Male bighorn sheep are also likely to be adversely affected by herbivory treatments designed to remove critical shrub cover used as forage material to gain weight and obtain nutrients for the rut.

Alternatives

Alternative 1 would reduce all effects to negligible considering how little of the bioregion would be treated on an annual basis.

Alternatives 2 and 3 would have the same effects to wildlife as the proposed program.

Alternative 4 would reduce effects due to prescribed fire to negligible, but the possibility of disease transmission from livestock to desert bighorn sheep would still exist.

The program and alternatives, as they pertain to wildlife, will meet two of the goals established in Section 1.7 of the VTP. It is expected to maintain and enhance forest and range land resources, including forest health so as to benefit present and future generations and improve wildlife habitat.

A crucial indicator of forest health is the diversity and condition of a system's wildlife inhabitants. Under the proposed program, measures will be taken to ensure that adverse affects to wildlife species are avoided, thus maintaining this important element of forest health.

Rangeland resources will also be maintained and enhanced by implementing herbivory as a treatment type wherever possible under the proposed program.

Finally, treatments under the proposed program are expected to enhance forest and rangeland resources and improve wildlife habitat by reducing the risk of catastrophic wildfire, which is clearly to the detriment of both wildlife and livestock. Further, the reduction of stand- wildfire more closely resembles the conditions of the natural fire regime under which California's wildlife have adapted, thus resulting in more positive than negative effects to wildlife within the treatment area and possibly beyond.

Alternatives 2 and 3 would meet the goals of the VTP as they pertain to wildlife in the same ways as the Program.

Alternative 4 would not meet the goals of the VTP as they pertain to wildlife. Although the detrimental effects to wildlife of treatment would be eliminated, the potential for catastrophic wildfire would remain and likely be more damaging to wildlife than would implementation of the program. Ultimately, the Program, including the Mitigation Measures already in place and any additional avoidance/mitigation measures that may result from further analyses at the project level, is expected to be more favorable to wildlife, livestock and overall forest health than Alternative 4.

5.5.2.7 Determination of Significance

It is assumed that the VTP will not be extensive enough in terms of the acreage treated each year, or damaging enough in terms of adverse alterations to natural vegetation types to be of any cumulative threat to populations of common wildlife species, though there will be direct and indirect effects to individuals. For the same reasons, significant cumulative effects to more common (non-endangered) sensitive species are also not anticipated. Although indirect or direct substantial adverse effects to sensitive species could potentially occur as a result of treatment under the VTP (such effects on endangered species may constitute substantial cumulative effects due to small population size), most of these potential effects can be avoided or minimized through adherence to the checklist and MMRs. Direct effects, by definition, are virtually never positive, however appropriate avoidance measures, including surveys where necessary, implemented at the project level will eliminate negative direct effects on special-status wildlife. Our analysis of indirect effects is limited to effects of conditions resulting from treatment; potential reduced risk of wildfire is not considered.

Specifically, implementation of the proposed program may have a substantial adverse effect on northern spotted owl as a result of direct impacts resulting from prescribed fire. Indirect impacts could result from a reduction in spatial heterogeneity in vegetation, a reduction in tree diversity (thus impacting the species' prey base) and/or a reduction in canopy cover. Further, any of these effects could constitute a negative impact to northern spotted owl habitat, thus violating the federal ESA and resulting in a substantial adverse effect. As such, Mitigation Measure 5.5.2-1 will be implemented which will reduce this impact to a level of less than significant.

Valley elderberry longhorn beetle may also suffer a substantial adverse effect as a result of implementing the proposed program as a consequence of both direct and indirect impacts associated with any loss of blue elderberry, the plant species that valley elderberry longhorn beetle is dependent upon for breeding. Such a loss would also violate the federal ESA. As such, Mitigation Measure 5.5.2-3 will be implemented which will reduce this impact to a level of less than significant.

A potentially substantial adverse effect to San Joaquin kit fox may result from implementation of the proposed program as a result of both direct and indirect impacts associated with destruction of fox burrows and dens that may result from mechanical treatments in grassland habitats where San Joaquin kit fox occurs. Such habitat destruction would also violate both the federal and state ESA's. As such, Mitigation Measure 5.5.2-4 will be implemented which will reduce this impact to a level of less than significant.

Implementation of the proposed program may also have a substantial adverse effect on California tiger salamander as a result of both direct and indirect impacts potentially resulting from treatments that destroy burrows or surface cover in suitable habitat for the species, thus also violating the federal ESA. As such, Mitigation Measure 5.5.2-5 will be implemented which will reduce this impact to a level of less than significant.

California red-legged frog may be adversely affected as a result of implementing the proposed program due to direct and indirect impacts associated with fuel reduction treatments in areas with dense vegetation and deep leaf litter in riparian zones (critical habitat elements for California red-legged frog). Should this occur; a violation of the federal ESA would also result. As such, Mitigation Measure 5.5.2-7 will be implemented which will reduce this impact to a level of less than significant.

Implementation of the proposed program may have a substantial adverse effect on burrow-dwelling special status taxa as a result of direct and indirect impacts associated with the potential for vehicles or heavy livestock to crush burrows or compact the soil, rendering the area uninhabitable. This would also result in the violation of both the state and federal ESA's. As such, Mitigation Measure 5.5.2-8 will be implemented which will reduce this impact to a level of less than significant.

A number of special-status taxa considered herein may suffer an adverse effect as a result of treatments conducted during certain times of the year when these species are particularly vulnerable to such impacts. Treatments with the potential to adversely impact special-status taxa, if conducted at a seasonally inappropriate time, may result in both direct and indirect impacts and/or violation of the state and/or federal ESA's. As such, Mitigation Measure 5.5.2-10 will be implemented which will reduce this impact to a level of less than significant.

Implementation of the proposed program may have a substantial adverse effect on Smith's blue as a result of direct and indirect impacts resulting from removal of buckwheat, which Smith's blue occurs in association with, as a result of treatment as well as a violation of the federal ESA. As such, Mitigation Measure 5.5.2-11 will be implemented which will reduce this impact to a level of less than significant.

Black legless lizard may suffer an adverse effect as a result of implementing the proposed program due to both direct and indirect impacts associated with removal of native shrub cover or leaf litter where black legless lizard occurs. As such, Mitigation Measure 5.5.2-12 will be implemented which will reduce this impact to a level of less than significant.

5.5.2.8 Similar Effects Described Elsewhere

Other species that inhabit the riparian zone or make use of aquatic ecosystems are included in Aquatics (Section 5.5.1).

5.5.2.9 Mitigation Measures for the Proposed Project

The following Mitigation Measures have been developed to reduce potentially significant impacts to impacts that are less significant:

Mitigation Measure 5.5.2-1. Overstory canopy cover shall not be reduced within occupied northern spotted owl territories within the project area.

Mitigation Measure 5.5.2-3. In areas where vegetation that provides critical habitat for special status taxa (such as valley elderberry in longhorn beetle habitat) occur, only hand (manual) treatments shall be used. Crewmembers shall be trained to recognize and avoid vegetation of particular concern where it occurs. Treatments shall focus on invasive plants that may inhibit establishment and growth of such species where it has been deemed appropriate by a biologist, botanist or agency personnel.

Mitigation Measure 5.5.2-4. Mechanical treatments shall not be used where special status burrowing species (for example, San Joaquin kit fox), or those for which burrows are a critical habitat element, are known or likely to occur unless extensive burrow surveys are carried out in the treatment area immediately prior to treatment and no-treatment buffers are established around any burrows that are found.

Mitigation Measure 5.5.2-5. In areas where special status terrestrial amphibians such as salamanders are known or likely to occur, prescribed fire shall be monitored closely post project to determine if burned cover objects should be replaced. New unburned cover objects shall be introduced at a one-to-one rate (or higher) to replace unsuitable burned cover objects and to enhance habitat quality for salamanders.

Mitigation Measure 5.5.2-7. Mechanical and prescribed fire treatments shall not be used in riparian zones bordering aquatic sites known or suspected to be in use by special status amphibians (for example, California red-legged frog).

Mitigation Measure 5.5.2-8. Where burrow-dwelling special-status taxa are found to be present, mechanical treatments and heavy livestock (*e.g.*, cattle) shall not be used.

Mitigation Measure 5.5.2-10. Treatments shall be conducted at the seasonally appropriate time to minimize impacts to special-status taxa.

Mitigation Measure 5.5.2-11. Treatments shall not remove essential habitat elements of special status taxa know or likely to occur in the area (for example, buckwheat in Smith's blue habitat).

Mitigation Measure 5.5.2-12. Where appropriate, as determined by a biologist or agency personnel, treatments occurring in areas where invasive species are a detriment to special status taxa, removal of invasives and retention of native species will be emphasized (for example, treatments in black legless lizard habitat).